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MANUAL OF ANATOMY

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From identical Bronze Plaques in the Dissecting Rooms, Trinity College, Dublin, and the University of Edinburgh

CUNNINGHAM'S MANUAL
OF
PRACTICAL ANATOMY

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TENTH EDITION

VOLUME THIRD

HEAD AND NECK: BRAIN

WITH 16 PLATES (INCLUDING 12 RADIOGRAPHS) AND 218 OTHER ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

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PREFACE TO THE TENTH EDITION

In the preparation of this edition, which appears in war-time, no great changes have been made; but the text has been revised thoroughly. The chief alterations in the text are the outcome of the continued pursuit of objects aimed at in the Ninth Edition.

In each volume, we have made some alterations in the sequence of the dissection and description where that seemed advisable; and here and there—notably in the description of the deep muscles of the Back—we have cut out descriptive detail that we thought medical students could dispense with or which can be adequately dealt with only in the large text-books.

A few of the old figures have been omitted without sacrifice of the illustration of any important structure; and a new figure from a drawing by Mr. R. W. Matthews has been added to illustrate the Axillary Region and the Sterno-Clavicular Joint.

Several new radiographs (for which we are indebted to Dr. Robert McWhirter) have been added to the series of Plates; and new blocks have been made for others. There has been some rearrangement of the Plates; and some former Plates which were printed on text-pages in the Ninth Edition have been reinstated to permit the secure binding of all the Plates in the volumes.

As the Birmingham Nomenclature is now in common use in this country, the glossary at the beginning of each of the volumes in the Ninth Edition has probably served its purpose ; but we have retained it in Volume I. for the convenience of those who may still wish to refer to it.

We are grateful to a number of friends and correspondents who have assisted us by making suggestions and by calling attention to discrepancies and omissions—especially to Dr. A. A. Abbie, Dr. G. I. Boyd, Mr. Lewis Graham, F.R.C.S., and Dr. W. F. Johnson of New York.

We owe thanks also to Emeritus-Professor Arthur Robinson, who has shown his continued interest by reading the proofs of all three volumes of this edition of the *Manual* of which he was the Editor for nearly half of its lifetime of fifty-one years. Some of our readers may be interested to note that the *Manual* reached the year of its Jubilee in 1939 —or Diamond Jubilee, if the years of its existence as a *Dissector's Guide* (1879–89) are included.

J. C. B.
E. B. J.

DEPARTMENT OF ANATOMY,
UNIVERSITY OF EDINBURGH,
June 1940.

EXTRACTS FROM PREFACE TO THE NINTH EDITION

THE character of the book as a dissector's guide remains unaltered, but we have thought it advisable to make certain changes which we hope will bring the student's work in the dissecting-room into still closer relation with his study of the living body, and will further emphasise the kind of knowledge expected of him in his clinical work.

We have increased the stress laid on the importance of the relations of structures to the surface of the body, have reversed the relative emphasis laid on arteries and nerves and have given a fuller account of lymph-drainage. We have made more frequent reference to function and to the application of anatomical facts in the diagnosis and treatment of disease.

By referring to observations on the living body, we have also tried to correct the impressions of the form and position of viscera which the dissector obtains from the embalmed cadaver. Most of the illustrations of X-ray Anatomy have been replaced by radiographs in negative reproduction, such as the student sees in demonstrations and in clinical practice.

We are aware that our most important reader is the student who has not dissected the part before, and one of our aims has been to lighten his task. We have therefore given him, in Volume I., a General Introduction to the structures met with in a dissection, and, throughout, have striven to avoid putting information before him at a stage when he cannot understand it.

We have replaced the Basle Nomina Anatomica by the anglicised version of a revision of that nomenclature which was adopted by the Anatomical Society at Birmingham in 1933. The advantage of the use of this revision is twofold: it is accepted by all British teachers; and the anglicised form makes the text easier to read and more easily understood by the dissector—who is the reader for whom the book is primarily written. For the sake of those already familiar with the Basle terms, we have inserted a glossary of the names in the Birmingham Revision that differ radically from the B.N.A.

Most of the old illustrations have been retained unchanged, but a few have been omitted, some have been coloured, and others have been replaced; and a number of entirely new figures have been added.

J. C. B.
E. B. J

DEPARTMENT OF ANATOMY,
UNIVERSITY OF EDINBURGH,
June 1935.

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MANUAL
OF
PRACTICAL ANATOMY

HEAD AND NECK

THE dissectors of the Head and Neck begin work as soon as the cadaver is brought into the room. During the first three days, while the body is in the lithotomy position, they study the surface anatomy of the head, and dissect the scalp and the superficial structures of the temple and face. For the convenience of the dissectors of the Abdomen and Limbs, the body is then laid on its back for five days. On the first of those five days, the dissectors of the Head and Neck complete the dissection of the face, and revise the work done; the next four days are devoted to the dissection and study of the posterior triangle of the neck, which is a specially important region to the surgeon, and must be displayed before the dissectors of the Upper Limb have disturbed its posterior boundary.

In order to ensure that the dissection of the scalp, temple and face is completed within the time allotted, apportion the work as follows :—

First Day.—Surface anatomy ; scalp and temple.
Second Day.—Survey of scalp ; superficial muscles of face.
Third Day.—Surface of parotid gland ; vessels and nerves of face.
Fourth Day.—Deeper muscles ; eyelids ; lacrimal apparatus ; nasal cartilages ; review of work done.

SCALP—TEMPLE—FACE

Surface Anatomy.—The dissectors should provide themselves with a dried skull; and they should examine, on the living head, the parts mentioned and then identify them on the head of the cadaver.

Examine the *auricle* first (Fig. 5). It is nearer the back of the head than the front, and is at the level of the eye and nose. The *concha* of the auricle is the " well of the ear," and leads into the *external auditory meatus*. The *helix* is the outer rim. It begins in the concha, and ends at the *lobule*, which is the soft, lower end of the auricle. The *tragus* is the small lid that overlaps the concha anteriorly; hairs project backwards from it, and, to some extent, prevent small foreign bodies from entering the external meatus; they become thicker and stronger after middle age.

Turn now to the back of the head. The *external occipital protuberance* is the knob felt in the median line where the back of the head joins the back of the neck. Feel for the *superior nuchal line*—a curved, indistinct ridge that extends in a lateral direction from the protuberance towards the mastoid process; it marks the boundary between the head and the neck at the back. The *mastoid process* is the smooth, rounded bone behind the lower part of the auricle and overlapped by it. Press the finger tip into the hollow below the mastoid process, behind the jaw: the bony resistance felt is due to the tip of the transverse process of the atlas vertebra; the chief soft structures between the finger and the bone are the lower part of a large gland called the *parotid gland* and the anterior border of the *sterno-mastoid muscle*.

Identify the *supramastoid crest* on the skull. It is a blunt ridge that begins immediately above the external auditory meatus and curves upwards and backwards for an inch. Then, find its position on the head by pressing the finger tips on the skin above the posterior part of the root of the auricle. The *parietal eminence* is the region of accentuated convexity where the back of the head meets the top and the side of the head.

Passing forwards over the top of the head, you come to the *frontal eminence*, where the top, the front and the side of the head meet. On the side of the head, feel for the *temporal line*. It is the narrow, curved ridge that marks the upper limit of the temporal region. The only part of the line that can be felt distinctly is its anterior part, which separates the forehead from the temple. The line begins at a prominence felt at the lateral end of the eyebrow, arches upwards and

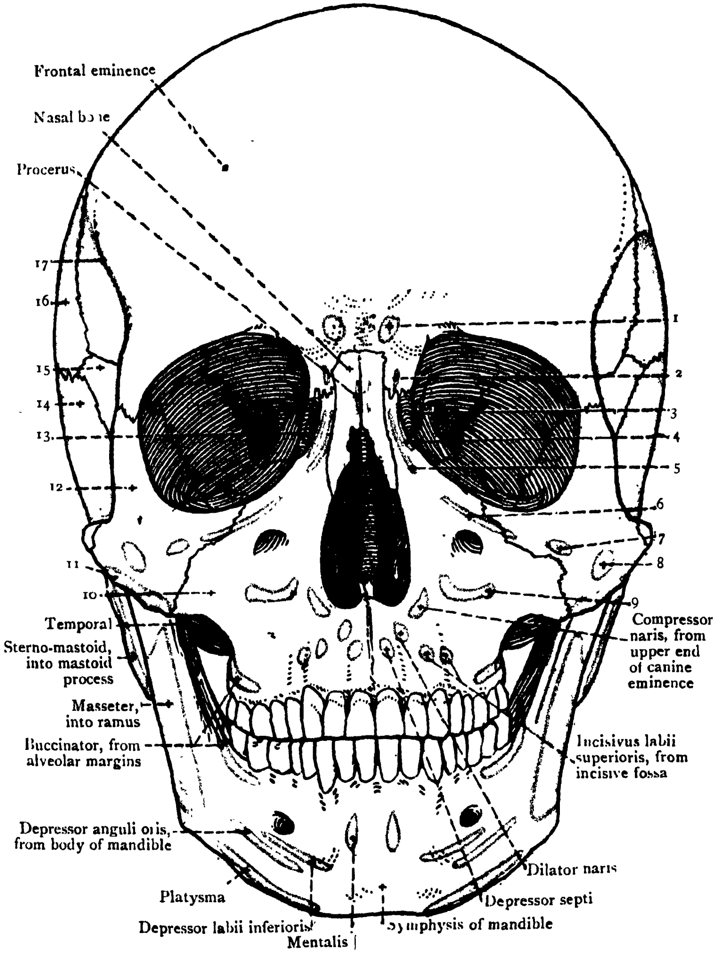

Frontal eminence
Nasal bone
Procerus
17
16
15
14
13
12
11
10
Temporal
Sterno-mastoid, into mastoid process
Masseter, into ramus
Buccinator, from alveolar margins
Depressor anguli oris, from body of mandible
Platysma
Depressor labii inferioris
Mentalis
Symphysis of mandible
Depressor septi
Dilator naris
Incisivus labii superioris, from incisive fossa
Compressor naris, from upper end of canine eminence
1
2
3
4
5
6
7
8
9

FIG. 1.—Anterior View of Skull showing Muscular Attachments.

1, 2, 3, 4. Orbicularis oculi.
5. Levator labii superioris alæque nasi.
6. Levator labii superioris.
7. Zygomaticus minor } from zygomatic bone.
8. Zygomaticus major } from zygomatic bone.
9. Levator anguli oris, from maxilla.
10. Zygomatic process of maxilla.

11. Masseter, from zygomatic arch.
12. Frontal process of zygomatic bone.
13. Lacrimal bone and fossa.
14. Squamous temporal } temporal muscle.
15. Greater wing of sphenoid } temporal muscle.
16. Parietal bone } temporal muscle.
17. Temporal line.

backwards, passing a little below the parietal eminence, and, finally, turns downwards to run into the supramastoid crest.

On the face, the outstanding feature is the *external nose* (the term " nose " includes also the cavities that extend backwards from the nostrils into the head for two or three inches to communicate with the pharynx). Grasp the nose between finger and thumb. Its lower part is movable, as it is made chiefly of skin and cartilage. The upper part has a skeleton of bone, and is therefore rigid. The bones are : (1) The pair of *nasal bones*, which lie side by side in the bridge of the nose ; and (2), behind each nasal bone, the *frontal process of the maxilla*. Note that the skin is adherent to the cartilages, but can be moved over the bones. The part of the cavity of the nose immediately above each nostril is called the *vestibule of the nose*. The lateral wall of the vestibule is slightly expanded, and is called the *ala* of the nose. The vestibule is lined with skin from which hairs grow to guard the entrance.

Examine the *lips* and the *cheeks*. They are composed chiefly of muscle and fat covered with skin and lined with mucous membrane. The space that separates the lips and cheeks from the teeth and gums is called the *vestibule of the mouth*. It is seldom that all the *teeth* are present in a dissecting-room cadaver. A full set of adult teeth comprises 16 teeth in each jaw ; in each half of the jaw, counting from before backwards, there are 2 *incisors*, 1 *canine*, 2 *premolars* and 3 *molars*. The *oral fissure*, between the lips, is opposite the upper teeth near their biting edges ; the corner or *angle* of the mouth is opposite the first premolar tooth. The median groove on the upper lip is called the *philtrum*. Evert the lips, and note that, in the median plane, between the root of the lip and the gum, the mucous membrane is raised up into a ridge or fold called the *frenulum of the lip*.

Feel the *body of the mandible* below the lower lip and the cheeks, and trace its lower border backwards to the *angle* of the mandible, which is a point often used as a landmark. Identify the position of the *mental foramen*. It is about an inch and a half from the median plane, and about midway between the gum and the lower border of the mandible. The finger tip placed firmly on that spot in the living person can make out the foramen as a slight depression. The *oblique line* of the mandible is a blunt ridge that begins near the mental foramen, and extends backwards and upwards ;

to feel it, press firmly on the body of the mandible. The *ramus* of the mandible is the wide, flat plate that extends

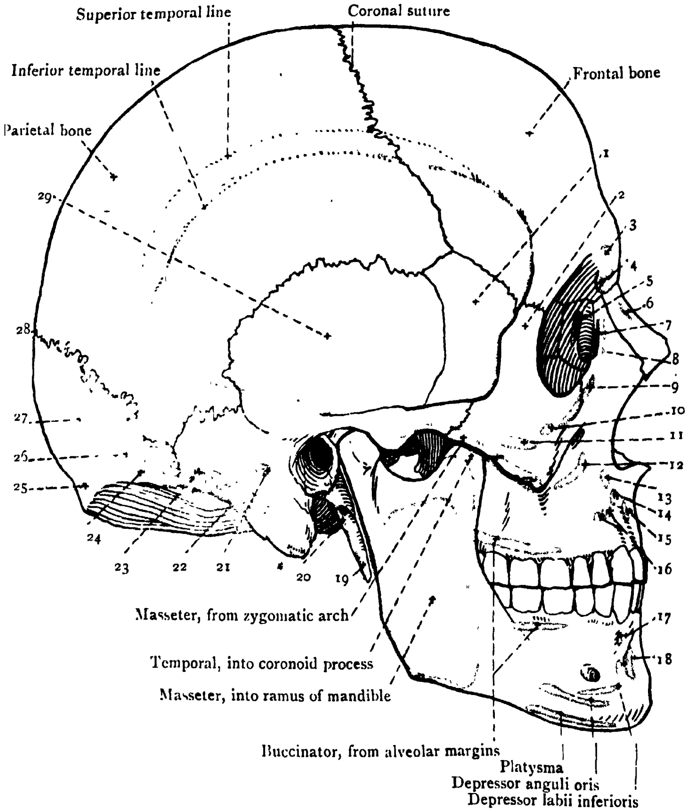


FIG. 2.—Lateral View of Skull showing Muscular Attachments.

1. Greater wing of sphenoid bone.
2. Frontal process of zygomatic bone.
3, 4. Orbicularis oculi, from frontal bone.
5. Orbicularis, from lacrimal crest.
6. Procerus and nasal bone.
7. Orbicularis, from frontal process of maxilla.
8. Levator labii superioris alæque nasi.
9. Levator labii superioris.
10. Zygomaticus minor } from zygomatic bone.
11. Zygomaticus major
12. Levator anguli oris, from maxilla.
13. Compressor naris.
14. Dilator naris. 15. Depressor septi.

16, 17. Incisive muscles.
18. Mentalis, from body of mandible.
19. Stylo-glossus } from styloid process.
20. Stylo-hyoid
21. Auricularis posterior } on mastoid temporal.
22. Longissimus capitis
23. Sterno-mastoid.
24. Splenius capitis } on superior nuchal line.
25. Trapezius
26. Occipital belly of occipito-frontalis.
27. Squamous part of occipital bone.
28. Lambda.
29. Temporal muscle and squamous temporal.

upwards from the posterior part of the body. It can be felt only indistinctly; for it is covered with a thick muscle, called the *masseter*, that can be felt hardening when the jaws are clenched. But the *condyloid process* can be distinctly felt. It stands up from the posterior part of the ramus, and includes the neck and head of the mandible. The *neck* is the bone felt immediately in front of the lobule of the auricle; the *head* is in front of the tragus. Place your finger tip in front of your own tragus, and open your mouth: the head of the mandible is felt gliding downwards and forwards.

The *tubercle of the root of the zygoma* is often used as a landmark. It is the bone felt immediately in front of the top of the head of the mandible when the mouth is shut, and immediately above it when the mouth is open. The *zygomatic arch* is the bony bridge that spans the interval between the ear and the eye. It begins at the tubercle of the zygoma; and the *zygoma* (or zygomatic process of the temporal bone) forms the narrow, posterior part of the arch. The wide, anterior part is the *zygomatic bone*, which is below and lateral to the eye, and forms the hard, prominent part of the cheek. In thin people, the zygomatic bone and arch are conspicuous.

The *orbit* is the socket for the eyeball. Its opening on the face is nearly four-square, and is slightly oblique. Examine the margins of the opening in the skull and in the body—both living and dead. The lower margin is formed by the *zygomatic bone* and the *maxilla*. Look and feel for the *infra-orbital foramen* a few millimetres below the orbit and a finger's breadth from the side of the nose. The lateral margin of the orbital opening is formed chiefly by the *frontal process of the zygomatic bone*. The medial margin is chiefly the *frontal process of the maxilla*, which forms part of the skeleton of the nose also. On the skull, look for a shallow, fairly wide, vertical groove on the medial wall of the orbit close behind the orbital margin. It is called the *lacrimal groove* because it accommodates a membranous bag called the lacrimal sac; it is continuous inferiorly with a short, wide passage, called the *naso-lacrimal canal*, which leads down into the cavity of the nose. The upper boundary of the orbital opening is the *supra-orbital margin* of the frontal bone, which forms also the upper parts of the lateral and medial boundaries. Its lateral end is the *zygomatic process of the frontal bone*—an important landmark which has been referred to already as the prominence felt at the lateral end of the eyebrow. Look and feel for the *supra-orbital notch*—a small dent on the supra-orbital margin about two finger-breadths from the median plane. In the living head, it is felt more easily when pressure is made from below. Occasionally it is converted into a foramen by a spicule of bone, and then cannot be felt.

The *eyebrow* is the fold of skin that covers the supra-orbital margin. The hairs that spring from it have a lateral inclination; in elderly people—especially men—they are thicker and longer than in young people. The *superciliary arch* is the thick, curved ridge of bone placed a little above the medial part of the supra-orbital margin. It is poorly marked (or even absent) in women, but is strongly marked in men, and is seen better when the eyebrow is drawn down. The smooth area between the right and left arches is called the *glabella.*

Complete the study of the surface anatomy of the head by examining the eyeball and the eyelids.

The white of the eye is called the *sclera.* The clear front of the eye is the *cornea.* The coloured part seen through the cornea is the *iris.* The black spot in the centre of the iris is a circular aperture called the *pupil.* All the visible part of the sclera is covered with a moist, transparent membrane called the *conjunctiva*, which is reflected off the sclera on to the eyelids, and lines their deep surfaces. The angle of reflexion, above and below, is named a *fornix* of the conjunctiva. The conjunctiva, as a whole, forms the *conjunctival sac.*

The *eyelids* or palpebræ are the movable curtains that protect the front of the eyeball; they join each other at the *lateral* and *medial angles* of the eye. The upper lid is more movable than the lower; it is also larger, and the upper fornix is therefore deeper than the lower. When the eye is open, the eyelids merely overlap the cornea above and below; the margins of the lids are slightly concave, and the *palpebral fissure* (rima palpebrarum) is therefore elliptical. When the eye is closed, the fissure is a nearly horizontal line; and, since the upper lid is the larger and more movable, the fissure is below the pupil—nearly opposite the lower margin of the cornea.

The medial part of the fissure, when open, is a small triangular space called the *lacus lacrimalis.* The *lacrimal caruncle* is the reddish, fleshy-looking elevation in the centre of the lake ; a few fine hairs project from its surface. Look for a small, curved, vertical fold or ridge of the conjunctiva that slightly overlaps the eyeball immediately lateral to the caruncle (Fig. 3). It is called the ***plica semilunaris***, and is a rudimentary representative of the nictitating membrane (or third eyelid) possessed by some animals.

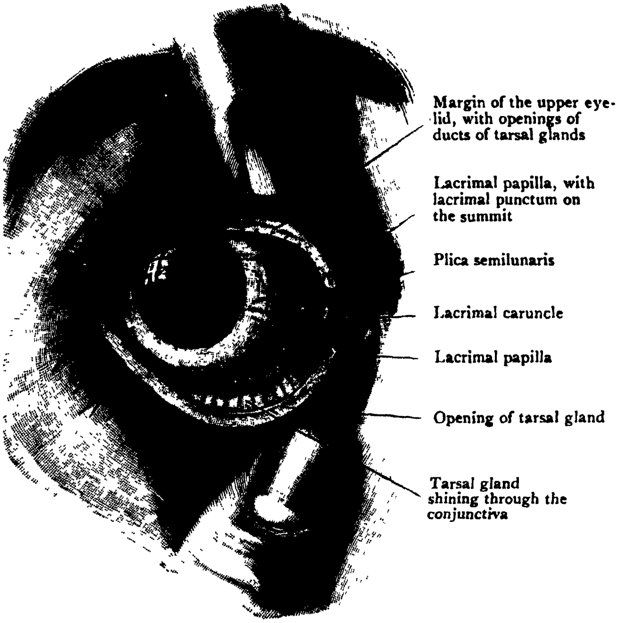

Margin of the upper eyelid, with openings of ducts of tarsal glands
Lacrimal papilla, with lacrimal punctum on the summit
Plica semilunaris
Lacrimal caruncle
Lacrimal papilla
Opening of tarsal gland
Tarsal gland shining through the conjunctiva

Fig. 3.—Eyelid slightly everted to show the Conjunctiva.

Evert the lids. The lower lid is easily turned inside out ; and, since it is small, the lower fornix can be seen when the eye is turned up. The upper lid is turned with difficulty, and, even when it is everted, the upper fornix cannot be seen. Look at the deep surface of a lid. A number of yellowish, parallel streaks are seen through the conjunctiva (Fig. 3). These are small glands called the *tarsal glands*. Examine the free margin of a lid. The portion that bounds the lacus is smooth and rounded. This portion ends laterally in a small eminence called the *lacrimal papilla*. On the summit of the papilla, there is a black speck called the *lacrimal punctum*—seen better in the lower lid than in the upper; the punctum is the open commencement of a very slender tube called the *lacrimal canaliculus.* Try to pass a bristle into the canaliculus; it runs medially in the edge of the eyelid, and ends in the lacrimal sac. The upper and lower canaliculi drain away such of the lacrimal fluid as is not evaporated or does not overflow the lids as tears. Note that the papillæ are turned backwards so that their summits touch the conjunctiva, and the puncta can thus receive the fluid more easily; note also that the upper papilla is nearer the nose than the lower is.

All the portion of the margin of the lid that is lateral to the papilla is flat, and is of appreciable width. The *eyelashes* or *cilia* project from the anterior edge of this flat margin; and the tarsal glands open on the posterior edge by a row of minute apertures (Fig. 3).

Press the finger tip on the skin between the nose and the medial angle of the eye, and feel a rounded, horizontal cord through the skin. That is a strong, fibrous band, called the *medial palpebral ligament*, which connects the two eyelids with the medial margin of the orbit, and crosses in front of the lacrimal sac. In some people, it raises the skin as a ridge when you draw the eyelids gently away from the nose to put the ligament on the stretch.

SCALP AND SUPERFICIAL PARTS OF TEMPLE

The first dissection is the examination of the scalp and the superficial structures in the temple.

The *scalp* is made up of the soft structures that cover the skull from one temporal line to the other and from the eyebrows to the superior nuchal lines. Its constituent parts are arranged in five layers :—

1. Skin.
2. Superficial fascia, containing the vessels and nerves of the skin.
3. Occipito-frontalis muscle, comprising a pair of occipital bellies united to a pair of frontal bellies by a thin, wide tendinous sheet called the epicranial aponeurosis.
4. A layer of loose areolar tissue.
5. Pericranium, which is the periosteum on the outside of the skull.

The *temple* is the area between the temporal line and the zygomatic arch. In this region, the skull is more thickly covered than in the scalp, and it is possible to distinguish six layers of soft tissues :—

1. Skin.
2. Superficial fascia, with vessels and nerves.
3. An extension of epicranial aponeurosis in which the extrinsic muscles of the auricle are embedded.
4. Temporal fascia.
5. Temporal muscle—the thickest of the layers.
6. Pericranium.

The scalp and the superficial temporal region are richly supplied with blood-vessels and nerves. They all enter from the periphery, passing into the superficial fascia after piercing the deep fascia of adjacent regions. As a consequence of that arrangement, large flaps of the scalp may be torn from the centre towards the margin, but, so long as they remain attached at the periphery, their sources of vitality are not seriously interfered with, and, if they are cleaned and replaced, healing occurs rapidly and satisfactorily.

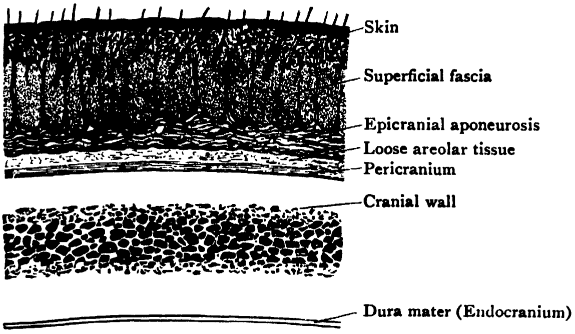


FIG. 4.—Section through the Scalp and Cranial Wall.

The first step in the dissection is the removal of the skin. This is no easy matter, for the roots of the hair pierce the skin obliquely, and their deeper parts are embedded in the superficial fascia (Fig. 4), and, in the scalp, the skin is closely bound to the fascia by fibrous strands. The skin is thin, especially near the auricle, and skin incisions must therefore be made with care. During the reflexion of the skin of the forehead, some laceration of the muscles is unavoidable, for many of their superficial fibres are implanted into the skin.

Place a block under the back of the head to raise it to a convenient angle.

Dissection.—Make a median incision from the root of the nose to the external occipital protuberance, and a coronal incision from the middle of the first cut to the top of the root of the auricle and then along the back and the front of the root to the mastoid process and to a point immediately below the zygoma. Reflect the four flaps of skin.

Having reflected the skin, turn to Figs. 8, 9, 14 and 58, and note the position of the muscles, vessels and nerves in the area exposed by the reflexion of the flaps; and note also in Figs. 8 and 58 the position of the *parotid gland*—below the zygoma immediately in front of the lower part of the auricle. The muscle seen in the forehead in Fig. 8 is the *frontal belly of the occipito-frontalis.* Its fibres run upwards and backwards from the eyebrows; and, at the eyebrows, they are overlapped by (and partly mingled with) the upper part of the *orbicularis oculi*, which is the muscle that surrounds the opening of the orbit.

Dissection. — Clean the *frontal belly* from below upwards, keeping the edge of the knife parallel with its fibres. As the cleaning proceeds, find the branches of the nerves and vessels that pierce the muscle, and trace them upwards; they are the *supratrochlear*, about a finger's breadth from the median line, and the *supra-orbital*, a finger's breadth more laterally (Figs. 8, 9, 58). Then, clean the anterior part of the *epicranial aponeurosis*, and note that its lateral margin, at the temporal line, sends an extension downwards into the temple.

Now, find two or more *temporal branches of the facial nerve* as they cross the zygoma about a finger's breadth (or more) in front of the auricle (Figs. 9, 58), and trace them upwards and forwards. As that is done, the anterior part of the *tempora fascia* will be exposed; and, as the orbit is approached, look for a slender cutaneous nerve—the *zygomatico-temporal*—which pierces the fascia a little behind the lateral margin of the orbit.

Next, find a group of structures that cross the zygoma above the parotid gland immediately in front of the auricle (Fig. 58). They are the *superficial temporal artery*, its *middle temporal* branch, the *posterior facial vein* and the *auriculo-temporal nerve.* The middle temporal artery disappears almost at once by piercing the temporal fascia. Trace the others (and their branches and tributaries) upwards. When the auriculo-temporal nerve reaches this part of its course it is so slender that it is difficult to find it, and it is liable to be injured. As these structures are traced upwards, a small thin muscle is encountered—the *auricularis anterior*—embedded in the extension from the epicranial aponeurosis immediately in front of the auricle; define it and clean it; and then pull down the auricle and define and clean the *auricularis superior*, which is immediately above the root, and

may be continuous with the anterior muscle (Figs. 8, 14, 58). Clean the whole of the *temporal fascia*, preserving the vessels, nerves and muscles exposed.

Pass now to the region that adjoins the back of the auricle, and trace and clean the structures found there :—Branches of the *great auricular* and *lesser occipital nerves*, which ascend from the neck (Fig. 14) ; the *posterior auricular vessels* and *nerve* immediately behind the root of the auricle ; and a small muscle—*auricularis posterior*.

Before proceeding farther with the dissection, examine the auricle of the external ear and its extrinsic muscles.

Auricula.—The **auricle** consists of a thin plate of yellow fibro-cartilage covered with skin. It is fixed in position by certain ligaments, and possesses two sets of feeble muscles—an *extrinsic* group, passing to the cartilage from the epicranial aponeurosis and the mastoid process, and an *intrinsic* group, attached to the cartilage alone.

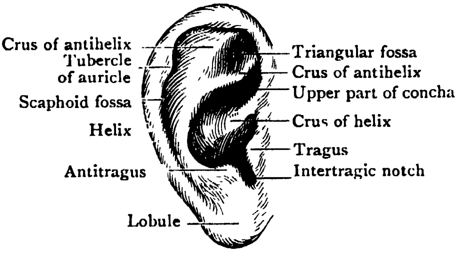


FIG. 5.—The Auricle.

The principal parts of the auricle were mentioned under Surface Anatomy on p. 2 ; they and the other parts are shown in Fig. 5.

The auricular cartilage extends throughout the entire auricle with the exception of the lobule and the part between the tragus and the helix. Those parts are composed of fatty fibrous tissue enclosed in skin.

The cartilage is continuous with the cartilage that forms the wall of the lateral part of the external auditory meatus. That cartilage is firmly fixed by fibrous tissue to the end of the bony part of the meatus ; but it does not form a complete tube, being deficient above and in front ; that part of the tube is completed by tough fibrous tissue which stretches between the tragus and the commencement of the helix.

Vessels and Nerves.—The vessels are small branches and tributaries of neighbouring arteries and veins. Branches of the facial nerve supply the muscles. The great auricular nerve supplies the skin of the lower third of the lateral surface and the lower two-thirds of the medial surface. The auriculotemporal supplies the rest of the lateral surface, and the lesser occipital the rest of the medial surface.

Extrinsic Muscles of Auricle.—The **auricularis anterior** arises from the lateral extension of the epicranial aponeurosis, and is inserted into the upper part of the front of the root of the auricle; it is supplied by temporal branches of the facial nerve.

The **auricularis superior** arises from the margin of the epicranial aponeurosis, and is inserted into the upper part of the root of the auricle. It is supplied by the temporal and posterior auricular branches of the facial nerve.

The **auricularis posterior** is a more definite bundle, and is fairly well developed in some people. It arises from the mastoid temporal bone above the root of the mastoid process, and is inserted into the back of the root of the auricle. It is supplied by the posterior auricular branch of the facial. Small lymph-glands, called *mastoid lymph-glands*, lie near it. The branch from the posterior auricular nerve occipital to the belly of the occipito-frontalis passes backwards along the lower border of the auricularis posterior or under cover of it.

The ligaments and intrinsic muscles of the auricle are of little importance; and the students will now go on to complete the dissection of the scalp.

> ***Dissection.*—Turn the head well over to the opposite side, and explore the superficial fascia over the external occipital protuberance for the terminal twigs that ascend from a slender nerve of the neck called the *third occipital nerve.* Now, identify the *superior nuchal line,* and gauge the thickness of the superficial fascia, which is exceptionally dense and tough in that situation; then, cut boldly through the fascia at the superior nuchal line one inch from the occipital protuberance, and find the *occipital vessels* and the *greater occipital nerve* as they pierce the deep fascia; trace them and their branches upwards to the crown. (If the neck is too rigid and unyielding to allow the head to be bent far enough forwards, this dissection may have to be deferred till the body is turned on its face.)**
>
> **Finally, clean the posterior part of the *epicranial aponeurosis* and the *occipital belly* of the occipito-frontalis from above downwards, avoiding injury to the nerves and vessels.**

The dissectors will now study the layers of the scalp and the nerves and vessels of the scalp and superficial part of the temporal region.

Layers of Scalp.—These layers are enumerated on p. 9. The *skin* is fairly thin, and is pierced by the hair-follicles which extend into the superficial fascia.

The *superficial fascia* is fibrous, dense and tough and is adherent to the skin. It is fairly easily removed from the fleshy bellies of the occipito-frontalis, but it is closely bound to the epicranial aponeurosis, and therefore the skin, fascia and aponeurosis move as one layer. The vessels and nerves ramify in the fascia before they enter the skin.

Occipito-frontalis (M. epicranius).—This muscle has two pairs of bellies united by the aponeurosis.

The **occipital bellies** are shorter and narrower than the frontal bellies, and are completely separated from each other by an extension backwards of the aponeurosis. Each arises from the lateral part of the superior nuchal line, and is inserted into the posterior border of the aponeurosis.

Each **frontal belly** is a thin sheet of muscle that lies in the forehead and adjoining part of the top of the head, and has no bony attachments. Posteriorly, it is continuous with the aponeurosis a little in front of the coronal suture. At the median plane, it is united to its fellow for a short distance above the nose. Anteriorly or below, it is inserted into the skin of the lower part of the forehead, being partly mingled with the orbicularis oculi before doing so; and, alongside the median plane, it sends down a small slip, called the **procerus** muscle, to be attached to the skin of the nose.

The *epicranial aponeurosis* (galea aponeurotica) is a strong, thin tendinous sheet—both long and wide—that overlies the top of the skull.

Anteriorly, it is continuous with the frontal bellies and sends down a spur for some distance between them. Posteriorly, it is continuous with the occipital bellies, but, between them, it is attached to the external occipital protuberance and the adjoining part of the superior nuchal lines (or to the highest nuchal lines if they are present). On each side, its margin is adherent to the temporal line, but also sends downwards a thin but fairly strong sheet which extends to the auricle and the zygomatic arch. This sheet is deep to the superficial fascia and vessels and nerves in the temple; and the anterior and superior auricular muscles are embedded in its superficial surface.

Between the right and left temporal lines, the epicranial aponeurosis is connected only loosely to the pericranium by the layer of loose areolar tissue; and the layer of united skin, fascia and aponeurosis can be easily torn from the pericranium—a circumstance taken advantage of by the Indians who scalped their defeated foes.

Actions and Nerve Supply.—The looseness of the areolar tissue beneath the aponeurosis permits the united layer to be drawn forwards and backwards by the alternate contractions of the frontal and occipital bellies. The extent of the movement varies in different people, and depends on the degree of firmness with which the aponeurosis is attached to the back of the skull. The frontal bellies also corrugate the skin of the forehead and are exercised in simulated surprise. The procerus muscles wrinkle the skin of the nose both in laughter and in a disapproving grimace.

The muscle is supplied by the facial nerve—the frontal belly by its temporal branches, the occipital belly by the posterior auricular branch.

Dissection.—**Introduce the handle of a scalpel through a median incision in the aponeurosis, and push it forwards and backwards and from side to side to ascertain the different degrees of looseness of the areolar tissue under different parts of the muscle.**

The **layer of loose areolar tissue** has few blood-vessels; and it is looser in the central area than towards the edges. It disappears at the supra-orbital margins, at the temporal lines and at the superior nuchal lines; effusions of blood or inflammatory exudations in the areolar tissue therefore easily raise the greater part of the scalp from the bone, but do not pass readily into either the face, the temple or the back of the neck.

Nerves of Scalp and Superficial Temporal Region (Figs. 14, 17, 20, 58).—Branches of ten pairs of nerves are found in the superficial fascia of the area. Five of them are mainly in front of the auricle and five behind it; and, of each group, one is motor and four are sensory. They communicate with one another so freely that every part of the skin is supplied by more than one nerve.

The motor nerve in front of the auricle is the *temporal branch* or *branches* of the *facial nerve.* The four sensory nerves are all derived from the trigeminal nerve; they are the *supratrochlear*, the *supra-orbital*, the *zygomatico-temporal*, and the *auriculo-temporal.*

The motor nerve behind the auricle also is a branch of the facial—the *posterior auricular.* The four sensory nerves are the *great auricular*, the *lesser occipital*, the *greater occipital*, and the *third occipital.*

These nerves, together with those of the face, are all derived from four nerves—the motor branches come from the *facial*; the sensory from the *trigeminal* and the *second* and *third cervical.*

At the back of the head, the muscular nerve is, as already stated, the posterior auricular branch of the facial nerve. The source of the cutaneous nerves is as follows—the *third occipital* comes from the posterior primary ramus of the third cervical nerve, the *greater occipital* from the same ramus of the second nerve, the *lesser occipital* from the anterior primary ramus of the second, and the *great auricular* from the anterior primary rami of the second and third.

Branches of three nerves are found in the face and the anterior half of the head—namely, the great auricular, the trigeminal and the facial.

The *great auricular* is the least important; one of its branches supplies the skin that overlies the lower half of the ramus of the mandible. All the rest of the skin of the area is supplied by the *trigeminal nerve,* which is the fifth cranial nerve. It derives its name from the fact that it is divided into three large nerves—ophthalmic, maxillary and mandibular—which escape from the cranial cavity separately. Each of those three divisions provides branches for the supply of the skin of the face and anterior half of the head.

The *facial* is the seventh cranial nerve; and its terminal branches are spent in supplying the muscles of the face, scalp and auricle. These branches communicate freely among themselves; they also receive numerous communicating branches from the divisions of the trigeminal nerve which convey to them the sensory fibres for the muscles. In consequence of these two kinds of communications, there are intricate interlacements that add greatly to the difficulty of dissecting the nerves.

The **supratrochlear nerve** arises in the orbit. It is one of the two terminal branches of the frontal nerve, which is a branch of the ophthalmic division of the trigeminal. It emerges at the supra-orbital margin about a finger's breadth from the median plane, gives a twig to the upper eyelid, pierces the frontal belly a little above the orbital margin, and supplies the skin of the forehead near the median line.

The **supra-orbital nerve** is the other and larger terminal branch of the frontal nerve. It emerges through the supra-orbital notch, sends filaments to the upper eyelid, and then *divides into a lateral and a medial branch, both of which send twigs through the bone to the mucous lining of the frontal sinus—that is, the cavity in the frontal bone above the nose and the orbit.* The medial branch pierces the frontal belly of the occipito-frontalis ; the lateral branch pierces the anterior part of the aponeurosis ; and both branches supply skin of the forehead and of the top of the head as far back as the lambdoid suture.

The **zygomatico-temporal nerve** is very slender. It arises in the orbit from the zygomatic branch of the maxillary nerve, enters the zygomatic bone and emerges again through its temporal surface, pierces the temporal fascia behind the frontal process of the zygomatic bone, and supplies the skin of the anterior part of the temple.

The **auriculo-temporal nerve** arises in the infratemporal fossa from the mandibular division of the trigeminal. It comes to the surface at the upper end of the parotid gland, close to the auricle, immediately below the root of the zygoma. It gives branches to the upper part of the auricle and external auditory meatus, and then ramifies to supply the skin of the side of the head.

The **temporal branches of the facial nerve** come to the surface through the front of the upper end of the parotid gland, cross the zygomatic arch obliquely, and pass upwards and forwards into the side of the head and the forehead. They supply the superior and anterior auricular muscles, the frontal belly of the occipito-frontalis and the upper part of the orbicularis oculi.

The **posterior auricular nerve** arises from the facial nerve immediately after that nerve escapes from the skull through the stylo-mastoid foramen. It curves upwards close to the back of the root of the auricle, and divides into branches which supply (1) the occipital belly of the occipito-frontalis, (2) the auricularis posterior and part of the auricularis superior, and (3) the intrinsic muscles of the auricle.

The trunks of the **great auricular** and **lesser occipital nerves** will be found when the side of the neck is dissected. The great auricular comes from the second and third cervical nerves, and its terminal branches supply skin of (1) the lower, posterior part of the face, (2) the lower part of the auricle, and (3) a small area behind the auricle. The lesser occipital arises from the second cervical nerve ; its terminal branches supply the upper part of the back of the auricle and a variable area of skin in the lateral part of the back of the head (Fig. 14).

The **greater occipital nerve** is a large nerve. It is the cutaneous branch of the posterior primary ramus of the second cervical nerve. It reaches the surface by piercing the trapezius and the deep fascia at the superior nuchal line about an inch from the occipital protuberance. It divides into branches which communicate with the branches of the lesser occipital and great auricular, and supply most of the skin of the back of the head.

The **third occipital nerve** is very slender. It is the cutaneous branch of the posterior primary ramus of the third cervical nerve. It pierces the trapezius, supplies the skin of the uppermost part of the back of the neck and the skin over the occipital protuberance.

Arteries of Scalp and Superficial Temporal Region.—These arteries are five in number on each side ; they anastomose freely, and are derived either directly from the external carotid artery or indirectly from the internal carotid. Three are distributed mainly in front of the auricle, and two behind it.

The three in front of the auricle are the *supratrochlear*, the *supra-orbital*, and the *superficial temporal*. The two behind the auricle are the *posterior auricular* and the *occipital*.

The **supra-orbital artery** and the **supratrochlear artery** (A. frontalis) are small. They arise in the orbit from the ophthalmic artery, which is a branch of the internal carotid. They accompany the nerves of the same name.

The **superficial temporal artery** is a large vessel. It is one of the two terminal branches of the external carotid, and arises, behind the neck of the mandible, in or under cover of the parotid gland. It appears at the upper end of the parotid gland, pierces the deep fascia, crosses the posterior root of the zygoma immediately in front of the auricle and the auriculo-temporal nerve, ascends in the superficial fascia of the temple, and, about an inch above the zygoma, it divides into an anterior and a posterior terminal branch. The *posterior branch* runs towards the parietal eminence. The *anterior branch* runs sinuously towards the frontal eminence; it can usually be seen through the skin in the living person, especially in elderly people, in whom the sinuosity is more marked.

Besides the terminal branches, small branches arise from the superficial temporal, the chief of which are the transverse facial, the middle temporal and the zygomatic. The *transverse facial* runs forwards across the masseter, below the zygomatic arch. The *middle temporal* ascends over the root of the zygoma, passes through the temporal fascia, and ascends over the cranial wall; examine the side of a skull, and note the long, narrow vertical groove made by the middle temporal artery above the external meatus. The *zygomatic branch*, of variable size, runs forwards along the upper border of the zygomatic arch between two layers of the temporal fascia (Fig. 8).

The **posterior auricular artery** is small. It arises from the external carotid, under cover of the parotid gland. It runs first backwards and upwards along the upper border of the posterior belly of a muscle called the digastric, and then upwards behind the auricle, with the posterior auricular nerve.

The **occipital artery** is large. It arises from the external carotid in the front of the neck, and winds round to the back. Its *third part* enters the scalp by piercing the trapezius and the deep fascia at the superior nuchal line on the lateral side of the greater occipital nerve. It ramifies over the back of the head.

Veins of Scalp and Superficial Temporal Region.—The veins anastomose freely, and form a network in the superficial fascia of the scalp and temple. The network is drained by veins that correspond to the arteries and lie alongside them in the scalp and temple, but do not accompany their proximal parts. Their modes of termination are as follows:—

The *supratrochlear* and *supra-orbital veins* communicate with the veins of the orbit, and then unite at the medial angle of the eye to form the anterior facial vein, whose blood passes eventually to the internal jugular vein.

The *superficial temporal vein* accompanies the corresponding artery in the temple, but, immediately above the posterior root of the zygoma, it unites with the *middle temporal vein*, which pierces the temporal fascia at that point; and the trunk formed by their union is the ***posterior facial vein.*** This vein descends through the parotid gland, and terminates by dividing into anterior and posterior branches, which emerge through the lower end of the gland. The ***anterior branch*** joins the anterior facial vein to form the common facial vein, which ends in the internal jugular. The ***posterior branch*** unites with the ***posterior auricular vein*** on the surface of the sterno-mastoid muscle to form the external jugular vein.

The *occipital veins* run downwards alongside the artery to the back of the neck ; beyond that, a tiny vein is all that accompanies the artery, for the bigger veins then forsake the artery and pass forwards across the lateral border of the semispinalis capitis muscle to end in the ***suboccipital plexus*** of veins, which lies under cover of the semispinalis. *Emissary veins* connect tributaries of the occipital veins with the venous sinuses inside the skull :—one through the parietal foramen to connect with the superior sagittal sinus ; another through the mastoid foramen to connect with the sigmoid sinus.

Lymph-Vessels of Scalp and Temple.—The lymph-*vessels are numerous, but they cannot be displayed by ordinary dissecting methods. Nevertheless, it is important that the student should remember their usual terminations.* The lymph-vessels of the anterior area end in small lymph-glands which are embedded in the superficial surface of the parotid gland. Those of the posterior area terminate in lymph-glands which lie on the upper ends of the trapezius and sterno-mastoid.

FACE

On the third day after the body is brought into the room, the students will prepare the face for dissection.

Remove the block from behind the head, and bring the head to a convenient position.

Place a little tow or cotton wool, steeped in preservative solution, in the conjunctival sac, in order to stretch the eyelids, and stitch the margins of the lids together. Put the cheeks and lips slightly on the stretch by placing tow or cotton wool, steeped in preservative solution, in the vestibule of the mouth, and stitch the red margins of the lips together.

The face extends from the roots of the hair to the point of the chin, and from one auricle to the other ; the forehead is therefore common to the face and the scalp.

The first step in the dissection is the removal of the skin; and, as in the scalp so in the face and even more so, some laceration of muscles is inevitable for they are attached to the skin; but keep the edge of the knife playing against the skin in order to injure the muscles as little as possible.

Dissection.—Make a median incision from the forehead to the point of the chin, and a horizontal incision from the angle of the mouth to the posterior border of the mandible.

Reflect the lower flap downwards to the lower border of the mandible. Reflect the upper flap backwards, together with the anterior flap of the scalp, and leave it attached at the front of the auricle.

Having reflected the skin, turn to Fig. 7, note the names and position of the muscles, and then proceed to clean them.

Dissection.—Begin with the *orbicularis oculi*. First, identify the *medial palpebral ligament* by pulling the eyelids laterally to put it on the stretch. Then, clean the orbicularis, beginning with the part that lies on the orbital margins. The part in the eyelids is very thin and pale; be careful not to remove part of it with the fat. Look for a small nerve—the *palpebral branch of the lacrimal nerve*—which pierces the orbicularis to reach the skin of the lateral part of the upper eyelid.

Next, clean the *orbicularis oris*, and take care not to injure the other muscles of the lips which blend with its margins. Attempt to define the *depressor septi nasi*, which lies between the orbicularis oris and the septum of the nose.

Turn to the *frontal belly of the occipito-frontalis* at the root of the nose, find the *procerus* muscle (p. 14) near the median plane, and trace it downwards into the nose.

At the upper part of the side of the nose, secure the *levator labii superioris alæque nasi*, and trace it down to the ala of the nose and the upper lip, but avoid injury to the upper part of the *anterior facial vein*, which lies on its surface. Try to define the *dilator naris*, which is under cover of the levator, and the *compressor naris*, which is medial to it. Look for two slender nerves that run downwards on the nose, and clean them—the *infratrochlear* in the upper half of the nose, and the *external nasal* in the lower half (Fig. 9).

Trace the *anterior facial vein* downwards till it disappears under cover of the *zygomaticus major*. Clean the zygomaticus major, and also the *zygomaticus minor* if it is present; it is an occasional slip that lies medial to the zygomaticus major. Then, clean the *levator labii superioris*—raising the orbicularis oculi towards the eye to define the upper part of the levator.

Now, turn to the lower border of the mandible and clean the *platysma*—a broad, thin sheet of muscle which ascends from the neck. As its posterior fibres bend forwards towards the angle of the mouth they form part of a small muscle called the *risorius*. Define and clean the risorius. Lastly, define and clean the *depressor anguli oris*, and also the *depressor labii inferioris*, which lies in front of the depressor anguli and partly under cover of it.

The remaining muscles of the face lie in a deeper plane, and cannot be dissected until the superficial muscles have been studied.

FACIAL MUSCLES.—Remember throughout that branches of the **facial nerve** supply the facial muscles—those that you have now dissected, and those that you have yet to dissect.

The actions of many of the facial muscles are implied in their names. The actions of the others may be inferred from their position. As the skin was removed, it was noted that many muscular bundles were attached to it. The skin is the chief insertion of the facial muscles. When they contract they therefore move the skin and subcutaneous tissues, giving outward evidence of the emotions. Wounds of the face tend to gape, and require numerous stitches, for the fibres attached to the skin draw the margins of the wound apart.

Make a careful study of the *orbiculares* muscles. With regard to the other facial muscles that you have dissected, note their position carefully in order that you may fully understand the relations of the other structures; but their precise attachments are of little importance.

Orbicularis Oculi.—This muscle has three parts—an *orbital part* on and around the margins of the orbital opening; a *palpebral part* in the eyelids; and a *lacrimal part* related to the lacrimal sac.

The **orbital part** is the thickest and widest part. It extends laterally into the temple, downwards into the cheek, overlapping the muscles of the upper lip, and upwards into the forehead, where it blends with fibres of the frontal belly of the occipito-frontalis. The fibres of the orbital part are relatively dark and coarse. They arise from the medial palpebral ligament and the adjoining part of the medial orbital margin, sweep in curves round the orbital margin and come back to the same point medially, having no attachment laterally except a loose connexion with the skin. Some of the fibres that arise from the bone above the palpebral ligament are short, and end in the skin of the eyebrow.

The **palpebral part** is paler and thinner than the orbital part. Its fibres also arise from the medial palpebral ligament and the adjoining bone, and sweep round in curves, having no lateral attachment. At its periphery, the palpebral part is continuous with the orbital part. At the margin of each eyelid, a small bundle is partially isolated, and is called the *ciliary bundle* because it lies close behind the roots of the eyelashes.

The **lacrimal part** has not yet been dissected. It is a small, thin sheet that arises from the posterior margin of the lacrimal fossa and the fascial sheath of the lacrimal sac, curves forwards round the lateral side of the lacrimal sac, and divides into slips that run laterally in the eyelids.

Actions of Orbicularis Oculi.—The firm connexions of the muscle are at the medial corner of the eye; therefore, when it contracts, it draws the skin and the eyelids medially, and thus promotes the flow of the lacrimal fluid medially towards the lacrimal canaliculi. The palpebral part can contract independently to close the eye lightly, as in sleep and in blinking. The orbital part also can contract independently, screwing up the skin around the eye to give it partial protection from a bright light or wind and rain; and those of its fibres that are inserted into the skin of the eyebrow draw the eyebrow down in frowning, and draw the eyebrows closer together, producing one or more vertical furrows in the middle of the forehead. Both parts contract firmly to protect the eye from an unexpected bright light or sudden danger. They contract firmly also during strong expiratory efforts—a spasm of coughing, hearty laughter, the crying of a child. This is probably to compress the contents of the orbit and prevent over-distension of the orbital veins. The lacrimal part helps the palpebral part to draw the eyelids medially; by its connexion with the fascial sheath of the lacrimal sac it probably dilates the sac and widens the openings of the canaliculi.

Muscles of Nose.—These muscles are small and unimportant. They are (1) the *procerus*, (2) a portion of the *levator labii superioris alæque nasi* (p. 24), (3) *compressor naris* (Fig. 7), (4) the *dilator naris* and (5) the *depressor septi nasi*—little slips inserted from below into the ala and septum respectively.

Muscles of Lips and Cheeks.—These muscles are in two layers—a superficial and a deep.

Superficial muscles	Orbicularis oris; levator labii superioris alæque nasi; levator labii superioris; zygomaticus minor; zygomaticus major; risorius; part of platysma; depressor anguli oris; depressor labii inferioris.
Deeper muscles	Buccinator; levator anguli oris; incisivus superior; incisivus inferior; mentalis.

Only the members of the superficial group are at present displayed; the deeper muscles will be dissected after the superficial vessels and nerves have been cleaned and studied.

Orbicularis Oris.—The orbicularis oris is the sphincter muscle of the mouth. It forms the greater part of the substance of the lips, lying between the skin and the mucous membrane, and extending from the edge of each lip to its root.

It is not a simple muscle composed of bundles arranged in concentric curves, like the orbicularis oculi. Besides some intrinsic fibres of its own, it is composed of the fibres of all the other muscles named in the list on p. 23 (except mentalis). (1) The *intrinsic bundles* pass obliquely between the skin and the mucous membrane. (2) The *incisive slips* arise from the jaws opposite the roots of incisor teeth and pass laterally into the lips. (3) The *other muscles* converge upon the mouth; their fibres mingle and sweep in curves through the lips—some obliquely and some transversely.

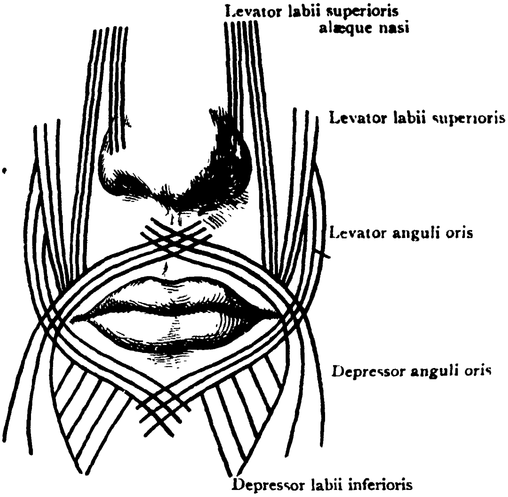


FIG. 6.—Diagram of the Orbicularis Oris Muscle.
The fibres which enter it from the buccinator are not represented.

Owing to this complex arrangement, the movements of the lips are very varied—closing, pressing against the teeth, pursing, protruding and twisting.

The *levator labii superioris alæque nasi* is a small muscle that lies alongside the attachment of the nose, and divides to be inserted into the ala and into the upper lip.

The *levator labii superioris*—thin and wide—descends from

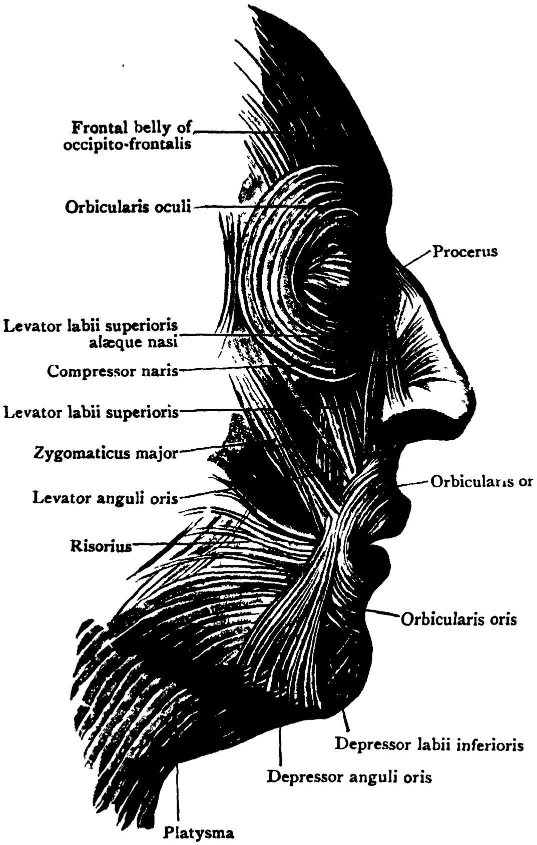


FIG. 7.—The Facial Muscles.

the infra-orbital margin into the upper lip It is overlapped by the orbicularis oculi.

The *zygomaticus minor* is lateral to the levator; it is a mere slip, and is often absent.

The *zygomaticus major* is both longer and thicker; it runs obliquely from the zygomatic bone to the angle of the mouth.

The *platysma* is a long, thin wide sheet of muscle. It arises from the skin and fasciæ below the clavicle, ascends in the superficial fascia of the neck, and enters the face. Its anterior fibres are inserted into the anterior part of the lower border of the mandible; its posterior fibres ascend over the posterior part of the border, and curve forwards into the lips. Only a small part of it is exposed; the rest will be seen when the dissection of the neck is begun.

The *risorius* lies horizontally opposite the angle of the mouth. It consists chiefly of the uppermost (or most posterior) bundles of the platysma (Fig. 7).

The fibres of the *depressor anguli oris* arise from the part of the mandible situated below the angle of the mouth, and converge upon the angle.

The *depressor labii inferioris*, short and wide, is in front of the depressor anguli and is overlapped by it.

The buccinator and the levator anguli oris belong to the deep group of muscles, and are not yet cleaned; but note their position now. The *levator anguli oris* is under cover of the levator labii superioris and the lower part of the zygomaticus major. The *buccinator* is the sheet of muscle that lies deep in the soft part of the cheek, next the mucous membrane.

Dissection.—**Detach the risorius and cut through the posterior half of the *platysma* along the lower border of the mandible, and turn them towards the mouth—avoiding injury to vessels and nerves (Figs. 8, 9, 58).**

Search for branches of the *great auricular nerve* which ascend over the lower part of the parotid gland.

Find the *anterior facial vein* and the *facial artery* at the lower and anterior angle of the masseter. Clean them at that point, but do not trace them farther at present.

Cut through the fascial covering of the *parotid gland* immediately in front of the auricle from the zygoma to the angle of the mandible; raise the fascia, dissecting carefully forwards, upwards, and downwards.

As the ends and the anterior border of the gland are approached, look for nerves and vessels which emerge from beneath them, and also for the *duct of the gland*, which appears at the anterior border about a finger's breadth below the zygoma. The parotid duct is of considerable size, and is easily recognised; trace it forwards to the anterior border of the masseter (Fig. 8).

Above the duct, find—(1) a small, detached part of the parotid gland called the *accessory parotid*; (2) small vessels called the *transverse facial artery and vein*; and (3) the *zygomatic branches of the facial nerve*. Below the duct, find the *buccal* and the *mandibular branches* of the facial nerve.

Take some pains to identify the structures at the anterior border of the parotid gland, and then trace the nerves forwards to their termination. This is a difficult and tedious dissection owing (as explained already) to the numerous communications which the branches of the facial nerve effect among themselves and with branches of the trigeminal nerve.

Dissection.—Begin with the zygomatic branches—the upper ones first. In following them, when you reach the orbicularis oculi, reflect its lateral part, and find the *zygomatico-facial nerve* as it emerges from the zygomatic bone. And when you reach the zygomaticus major, reflect that muscle and the zygomaticus minor and the levator labii superioris from their origins, and turn them downwards. Clean the *facial artery* and the *anterior facial vein,* following them upwards and downwards; clean the branches of the artery; find the *deep facial vein,* which passes backwards from the anterior facial through the fat and disappears under cover of the masseter. Then, trace the lower zygomatic branches still farther forwards till you find communications between them and branches of the *infra-orbital nerve.* Follow one of these to the trunk of the infra-orbital nerve as it emerges through the infra-orbital foramen, and then clean its branches.

Now, return to the anterior border of the parotid gland, secure the buccal branch of the facial nerve as it emerges below the duct, and trace it through the fat to the buccinator muscle; secure one of its communications with the *buccal nerve*—a branch of the trigeminal—and follow that nerve forwards in the cheek and backwards till it disappears under cover of the ramus of the mandible.

Trace the mandibular branch of the facial nerve forwards from the lower part of the parotid gland to the depressor anguli oris. Divide that muscle and turn it downwards, and find the communication between the mandibular branch and the *mental nerve,* which emerges through the mental foramen; clean the mental nerve and its branches.

The dissectors will now give their attention to the structures that appear at the ends of the parotid gland.

Dissection.—At the upper end of the parotid gland, identify again the vessels and nerves found when the scalp was dissected:—(1) The *superficial temporal artery,* ascending from the gland; (2) the *posterior facial vein,* descending into it; (3) a slender nerve called the *auriculo-temporal,* emerging behind the vessels, close to the auricle; and (4) the *temporal branches of the facial nerve,* emerging in front of the vessels. Trace them for a short distance downwards.

Find two veins and a nerve emerging from the lower end of the gland:—the *anterior* and *posterior branches* into which the lower end of the *posterior facial vein* divides (Fig. 15); and the *cervical branch of the facial nerve.* Clean them as they emerge from the gland, but do not trace them farther at present.

ARTERIES OF FACE.—The face is very generously supplied with blood-vessels, and wounds of the face therefore bleed freely but heal quickly. The arteries are :—(1) The facial artery; (2) the transverse facial artery; and (3) numerous

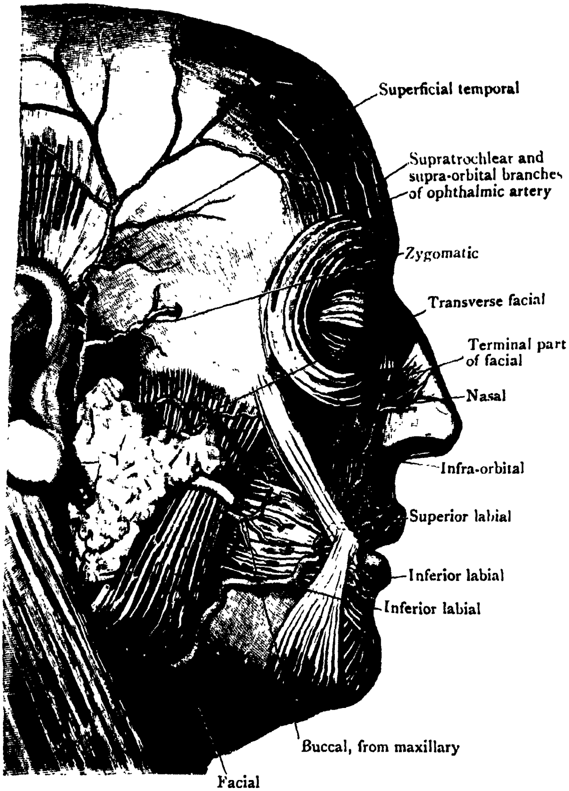


FIG. 8.—Arteries of Face. (*In this Fig.*, the lowest branch seen arising from the back of the superficial temporal is the middle temporal.)

arteries that accompany branches of the trigeminal nerve into the face and receive corresponding names. They anastomose freely with one another, so that there is a network of arteries in the face.

Transverse Facial Artery.—This is a small vessel that arises from the superficial temporal artery in or under cover of the parotid gland; it escapes from the gland near its upper end, and runs forwards over the masseter muscle below the zygomatic arch (Fig. 8).

Facial Artery (A. maxillaris externa).—The facial artery is by far the largest artery of the face, and is a sinuous vessel which arises in the neck from the external carotid artery; it enters the face at the lower and anterior angle of the masseter, after turning round the lower border of the mandible and piercing the deep fascia of the neck (Figs. 8 and 58). From that point it runs forwards and upwards to a point about half an inch from the angle of the mouth, and then ascends more vertically, in the substance of the levator labii superioris alæque nasi, to end near the *medial angle of the eye. Until* it enters the substance of that muscle, it is under cover of the platysma, risorius and levator labii superioris; and it lies first on the mandible, next on the buccinator, and then on the levator anguli oris. As it crosses the mandible, its pulsations can be felt in the living person, and it can be compressed against the bone.

Branches.—Small branches pass backwards to the muscles and skin behind the artery. Larger branches pass forwards, to the chin, the lips and the nose—see Fig. 8.

VEINS OF FACE.—The veins anastomose freely in the face, and form networks amid the fat and among the muscles. The networks are drained by veins that accompany the arteries, and by far the largest of them is the anterior facial vein.

Anterior Facial Vein.—This is the companion vein of the facial artery. It is behind the artery, on a more superficial plane at first; and it runs a straighter course. It begins at the medial angle of the eye by the union of the supratrochlear and supra-orbital veins, which descend from the forehead. It runs downwards and backwards, first on the surface of the levator labii superioris and the zygomaticus minor, and then under cover of the zygomaticus major, risorius and platysma, and reaches the lower border of the mandible at the antero-inferior angle of the masseter, immediately behind the facial artery. There it pierces the deep fascia and descends into the neck, where it joins the anterior branch of the posterior facial vein to form the common facial vein.

Tributaries.—In addition to the supratrochlear and supra-orbital veins, it receives tributaries that correspond to the branches of the facial artery. As it crosses the buccinator muscle it gives off the *deep facial vein*, which connects it with the pterygoid plexus of veins in the infratemporal fossa (p. 174).

NERVES OF FACE.—As stated already (p. 16), branches of three nerves are found in the face, namely, the great auricular, the trigeminal and the facial. The dissectors will now study the branches derived from the trigeminal and facial nerves.

Branches of Trigeminal Nerve in the Face (Fig. 9).—The first of the divisions of the trigeminal nerve (p. 16) is the **ophthalmic nerve.** It breaks up into three nerves—*frontal*, *lacrimal* and *naso-ciliary*—which will be dissected in the orbit; and each of these sends cutaneous branches to the face :—The *external nasal* and *infratrochlear* come from the naso-ciliary; the *supratrochlear* and *supra-orbital* are the terminal branches of the frontal; and a *palpebral* branch arises from the lacrimal.

The **maxillary nerve** is the second division. It becomes the *infra-orbital nerve*, whose terminal branches supply skin; and the zygomatic branch of the maxillary, which is found in the orbit, divides into two cutaneous nerves called the *zygomatico-facial* and the *zygomatico-temporal.*

The branches of the **mandibular nerve** that supply skin are the *auriculo-temporal* and the *buccal nerves*; and its dental branch sends the *mental nerve* to the skin.

The *external nasal nerve* is the terminal part of a branch of the naso-ciliary that runs part of its course inside the nose. It emerges between the nasal bone and the upper nasal cartilage, and supplies the skin of the lower half of the dorsum of the nose. The skin of the upper half is supplied by the *infratrochlear nerve*, which emerges from the orbit above the medial angle of the eye, and gives branches to the eyelids as well as to the nose.

The *supratrochlear* and *supra-orbital nerves* are described with the nerves of the scalp (pp. 16, 17).

The *palpebral branch of the lacrimal nerve* supplies the lateral part of the upper eyelid.

The *infra-orbital nerve* is a thick nerve that emerges from the infra-orbital foramen under cover of the orbicularis oculi and the levator labii superioris. It ends at once by dividing into :—(*a*) palpebral branches to the lower eyelid ; (*b*) nasal branches to the side of the nose ; and (*c*) labial branches to the skin and mucous membrane of the upper lip and the skin of the cheek between the upper lip and the eye. The name *infra-orbital plexus* is given to the network formed by these branches and their communications with each other and with the zygomatic branches of the facial nerve.

The *zygomatico-facial nerve* is very slender. It arises in the orbit, pierces the zygomatic bone, emerges through its facial surface, and supplies the skin over the bony part of the cheek.

The *zygomatico-temporal nerve* has been described already (p. 17).

The superficial part of the *auriculo-temporal nerve* also has been described already (p. 17).

The *buccal nerve* (n. buccinatorius) arises in the infratemporal fossa ; it passes downwards and forwards, and enters the cheek from under cover of the ramus of the mandible and masseter, lying on the lowest part of the buccinator ; some of its branches pass through the fat to the skin of the soft part of the cheek, and others pierce the buccinator to reach the mucous membrane.

The *mental nerve* arises in the interior of the mandible, emerges through the mental foramen under cover of the depressor anguli oris, and divides into radiating branches that supply the skin and mucous membrane of the lower lip and the skin over the mandible from the masseter to the symphysis menti.

Terminal Branches of Facial Nerve.—The facial nerve has five terminal branches or groups of branches :—

1. Temporal. 2. Zygomatic. 3. Buccal. 4. Mandibular. 5. Cervical.

They all emerge from under cover of the parotid gland—the temporal branches at its upper end, the cervical at its lower end, and the remaining three groups of branches at its anterior border.

The *temporal branches* are described on p. 17.

The upper filaments of the *zygomatic branches* run forwards across the zygomatic bone, and terminate in the orbicularis oculi. The lower filaments are larger. They run forwards along the lower border of the zygomatic bone, under cover of the zygomatic muscles and the levator labii superioris, and supply muscles of the nose and muscles between the eye and the mouth.

The *buccal branches* run towards the angle of the mouth, and supply the muscles of the soft part of the cheek.

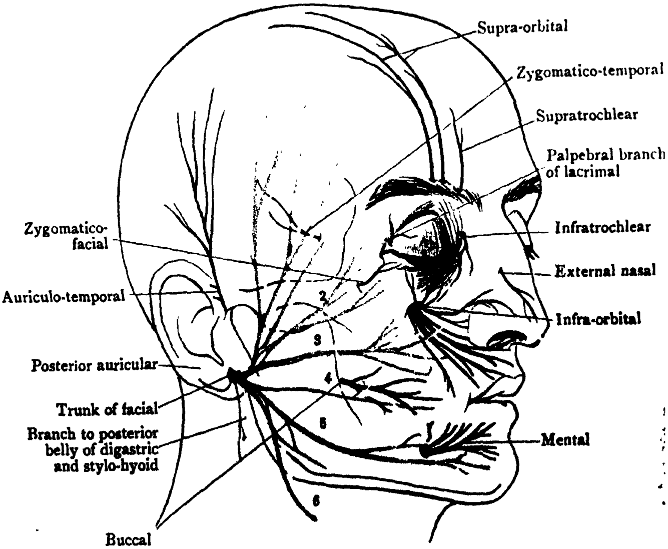


FIG. 9.—Nerves of the Face. The facial nerve (motor) is depicted in green, the branches of the trigeminal (sensory) in black.

1. Temporal branches.
2 and 3. Zygomatic branches.
4. Buccal branch.
5. Mandibular branch.
6. Cervical branch.

The *mandibular branches* run forwards along the mandible, and pass deep to the depressor anguli oris, in company with a labial branch of the facial artery, to be distributed to the muscles of the lower lip.

The *cervical branch*, after its exit from the lower end of the parotid gland, runs forwards and downwards, below the mandible, to supply the platysma and to communicate with the anterior cutaneous nerve of the neck (see p. 48).

On the fourth day after the body was brought into the room and the first day on which it is laid on its back, the students will proceed with the dissection of the deeper muscles, vessels and nerves, and will then examine the eyelids, the lacrimal apparatus and the external nose.

> ***Dissection.***—**Clean first the *levator anguli oris*, and then the *buccinator*. As the fat is being removed from the buccinator, avoid injury to the *buccal nerve*; and note the small *molar glands* which lie in the fat and the fascia which cover the muscle. Clear away the fascia, define the attachments of the buccinator to the maxilla and the mandible, and trace its fibres forwards to the angle of the mouth.**

Buccinator.—The buccinator muscle lies next the mucous membrane of the cheek, and is a most important part of the substance of the cheek. It arises from the outer surface of the maxilla and the mandible opposite the sockets of the molar teeth, and, between those two bony attachments, it springs from the [illegible] *ligament*. That ligament is a sl[illegible] from the pterygoid hamulus to t[illegible]ble; it is a bond of unio[illegible] constrictor mu[illegible]pharynx is dissected.

Anteriorly, the [illegible]ge towards the angle of the mouth, and blen[illegible] orbicularis oris, of which they form a large part. The upper and lower fibres pass directly to the corresponding lips; but the middle fibres decussate at the angle of the mouth, so that the lower fibres enter the upper lip, and the higher ones the lower lip.

Action.—The buccinator muscle, since it is supplied by the facial nerve, is not classified as a muscle of mastication, but it is used during mastication to press the cheek against the teeth and prevent the food from escaping into the vestibule of the mouth.

Bucco-pharyngeal Fascia.—This is the thin sheet of fascia that clothes the surface of the buccinator muscle and extends backwards to cover the constrictor muscles of the pharynx also. The parotid duct, on its way to the vestibule of the mouth, pierces the fascia, the buccinator and the mucous membrane; the fascia and the muscle are pierced also by the nerves and vessels of the mucous membrane.

Molar Glands and Buccal Lymph-Glands.—The molar salivary glands are four or five small *mucous* glands that lie on the bucco-pharyngeal fascia around the parotid duct. Their ducts pass through the fascia, the buccinator and the mucous membrane to open into the vestibule of the mouth. The *buccal lymph-glands* are one or two small glands sometimes found on the surface of the fascia. They are softer in consistence than the molar glands, and the two kinds are distinguished further by their connexion with lymph-vessels and ducts.

Buccal Pad of Fat.—The buccal pad or "sucking pad" has been removed piecemeal as the nerves of the cheek were dissected. It is a mass of fat, encapsuled in fascia, that lies on the buccinator and is partly tucked in between the buccinator and the masseter. It is pierced by the buccal nerves, by small vessels and by the parotid duct. It thickens the cheek and helps it to resist atmospheric pressure during sucking. It is relatively much larger therefore in an infant than in an *adult; the rounded fullness of a child's cheek is due largely to the buccal pad.*

Levator Anguli Oris (M. Caninus).—The elevator of the angle of the mouth is concealed by the lower part of the orbicularis oculi, the levator labii superioris, and the zygomatic muscles, and it is crossed superficially near the angle of the mouth, by the facial artery. When the structures superficial to it are turned aside, the muscle will be found to spring from the canine fossa below the infra-orbital foramen. It passes downwards to the angle of the mouth, where it blends with the orbicularis oris; some of its fibres passing into the lower lip (Fig. 6).

Dissection.—**Remove the stitches from the lips; evert the lips and dissect the mucous membrane from the deep surfaces, in order to expose the *incisive muscles* and the *mentalis*. As the mucous membrane is removed a number of small *labial glands* will be seen. The incisive slips are found at the roots of the lips opposite the sockets of the incisor teeth (see p. 24). Detach the mandibular slips from the bone, and evert the lower lip still farther to find the mentalis.**

Mentalis.—The mentalis muscle arises by a pair of slips from the outer wall of the canine sockets. The slips converge and unite together to be inserted into the skin of the chin.

Labial and Buccal Glands.—The labial salivary glands are small, closely set *mucous glands* that lie in the submucous coat of the lips, and are palpable as little nodules when the tongue is pressed against the lip. Their ducts pierce the mucous membrane and open into the vestibule of the mouth. The buccal salivary glands are similar mucous glands that lie in the submucous coat of the cheeks.

EYELIDS: LACRIMAL APPARATUS: EXTERNAL NOSE

Eyelids.—In the eyelids or palpebræ, the following strata will be exposed as the dissection is carried from the surface towards the conjunctiva.

UPPER LID.	LOWER LID.
1. Skin.	1. Skin.
2. Superficial fascia.	2. Superficial fascia.
3. Orbicularis oculi.	3. Orbicularis oculi.
4. Tarsus, palpebral fascia, and tendon of levator palpebræ superioris.	4. Tarsus and palpebral fascia.
5. Conjunctiva.	5. Conjunctiva.

In addition to the structures which are arranged in layers, there are the *palpebral ligaments* at the ends of the tarsi, the *tarsal glands* on the deep surfaces of the tarsi, and the *ciliary glands* behind the roots of the eyelashes.

The **skin** of the eyelids is very thin, and its hairs (except the eyelashes) are so short that few of them appear above the surface.

The **superficial fascia** also is thin, and it contains no fat. Its superficial part is loose, and the skin therefore moves easily; it is on this part that blood accumulates in a "black eye". Its deeper part contains the palpebral part of the orbicularis oculi.

> ***Dissection.***—**Separate the palpebral part of the orbicularis oculi from the remainder by a circular incision; turn the palpebral part towards the palpebral fissure. While raising the muscle fibres, avoid injury to the palpebral fascia, vessels and nerves. As the dissection is completed the origin of the muscle from the medial palpebral ligament (p. 22) will be displayed.**

The removal of the palpebral part of the orbicularis oculi brings the palpebral fascia and the tarsi into view. They lie in the same morphological plane, and they constitute the ground-work of the eyelids (Fig. 10).

The **tarsi** are two thin plates of condensed fibrous tissue which lie close to the free margins of the eyelids, and stiffen them.

The *tarsus of the lower eyelid* is a narrow strip placed between the orbicularis and the conjunctiva, and its lower edge is connected with the inferior orbital margin by the palpebral fascia.

The *tarsus of the upper eyelid* is much larger, and can be *felt if the lid is pinched up sideways between finger and thumb. Its deep surface is adherent to the conjunctiva. The lower part of its superficial surface is covered with the orbicularis*; but the upper part and the upper border are separated from the orbicularis by (1) the palpebral fascia, which is attached not to its upper border but to its anterior surface some distance below that border, and (2) the tendon of the muscle called the levator palpebræ superioris, which expands and fuses with the back of the palpebral fascia (Fig. 11). The lower edge of the tarsus is adherent to the skin of the margin of the lid.

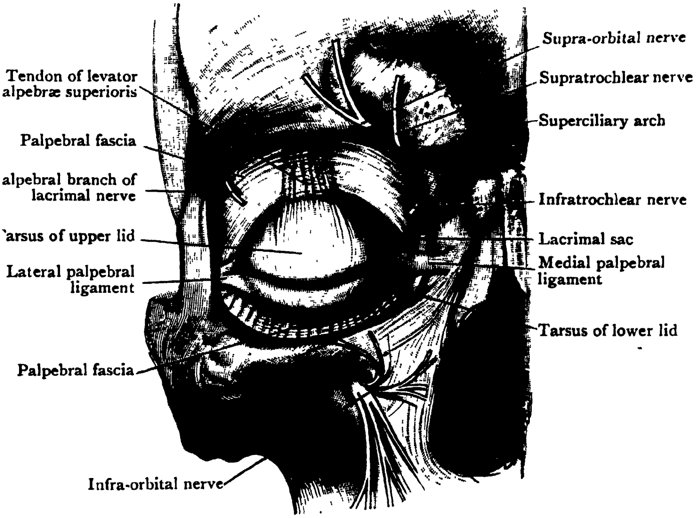


FIG. 10.—Dissection of Right Eyelid. The orbicularis oculi has been completely removed.

The **tarsal glands** lie in furrows on the deep surface of the tarsi. When a lid is everted, they are seen, through the conjunctiva, as closely-placed, parallel, yellow streaks that run at right angles to the margin of the lid. Their ducts open on the margin behind the eyelashes.

The **ciliary glands** are so minute that they cannot be found in an ordinary dissection. They are arranged in several rows immediately behind the roots of the eyelashes, and their ducts open on the margin of the lids near the eyelashes. Festering inflammation of one of them produces the red *swelling at the margin of the lid called a "stye."*

The ***palpebral fascia*** *is a thin fibrous membrane which*

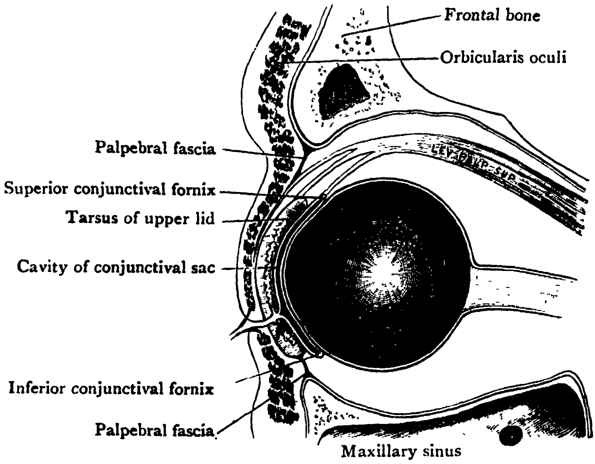


FIG. 11.—Diagram of the Structure of the Eyelids.

occupies the interval between the tarsi and the margins of the orbit, orming, with the tarsi, a *septum* between the orbit and the exterior. Its peripheral border is attached to the orbital margin, except at the medial side, where it passes behind the lacrimal sac to be attached to the posterior margin of the groove for that sac. The part in the lower lid is connected with the lower border of the tarsus. In the upper lid, it blends with the anterior surface of the expanded tendon of the levator palpebræ superioris, and is attached with it to the anterior surface of the upper tarsus. It is pierced by the nerves and vessels that emerge from the orbit above the eye.

Palpebral Ligaments.—The *medial palpebral ligament* is a strong fibrous band that connects the two tarsi with the *medial margin of the orbit. It lies under cover of the skin, across the front of the lacrimal sac, and gives origin to many of the fibres of the orbicularis oculi.*

The *lateral palpebral ligament* is a slender fibrous band that lies behind the palpebral fascia, separated from it by a little fat. It connects the two tarsi with a little tubercle on the lateral margin of the orbit.

Levator Palpebræ Superioris.—This muscle will be examined fully when the orbit is dissected; its tendon expands into a wide, thin sheet which enters the upper eyelid, where its superficial surface blends with the palpebral fascia. A few of the fibres of the tendon pass through the orbicularis oculi to be inserted into the skin; others are attached to the front and upper edge of the tarsus; and, by its fascial sheath, the tendon is connected with the upper fornix of the conjunctiva, which, by this means, is raised when the eyelid is raised.

Vessels and Nerves of Eyelids.—The **arteries** are derived from the ophthalmic and its lacrimal branch. These palpebral arteries pierce the palpebral fascia to enter the lids; they anastomose to form *arches* near the margins of the lids, between the tarsus and the orbicularis oculi.

The **veins** run medially towards the root of the nose, and end in the supratrochlear and anterior facial veins.

The **nerves** are numerous. The *motor nerves* to the orbicularis oculi come from the temporal and upper zygomatic branches of the facial nerve. The *sensory nerves* to the upper lid are the palpebral branch of the lacrimal nerve and twigs from the supra-orbital, supratrochlear and infratrochlear nerves. The infra-orbital nerve supplies the lower lid.

LACRIMAL APPARATUS.—The following structures are included under this head:

1. Lacrimal gland and its ducts.
2. Conjunctival sac.
3. Lacrimal canaliculi.
4. Lacrimal sac.
5. Naso-lacrimal duct.
6. Lacrimal fold.

Dissection.—Remove the upper, lateral part of the palpebral fascia in order to expose the anterior part of the _lacrimal gland_ and the part that juts down into the upper eyelid. Raise the gland, and move the point of the knife carefully up and down in the loose tissue below the gland to find its _ducts_.

Now, pass to the medial angle of the eye. If the lacrimal papillæ were not destroyed when the skin and the orbicularis were removed, pass a bristle through a lacrimal punctum into the canaliculus, and along it to the lacrimal sac.

Clean the medial palpebral ligament, and identify the _lacrimal sac_, which lies behind it. Note the lacrimal part of the orbicularis oculi as it curves forwards round the lateral side of the sac. Remove the muscle fibres and the fascia that covers the sac. Make an opening into the sac, and pass a probe into it, and down through the _naso-lacrimal duct_ into the cavity of the nose.

Lacrimal Gland.—The lacrimal gland (Figs. 12, 46, 47, 103) lies in the orbit, and will be fully examined when the orbit is dissected. Note now, however, that a part of it, called the *palpebral process*, extends down into the lateral part of the upper eyelid between the conjunctiva and the palpebral fascia, and may be seen bulging the conjunctiva when the lid is everted.

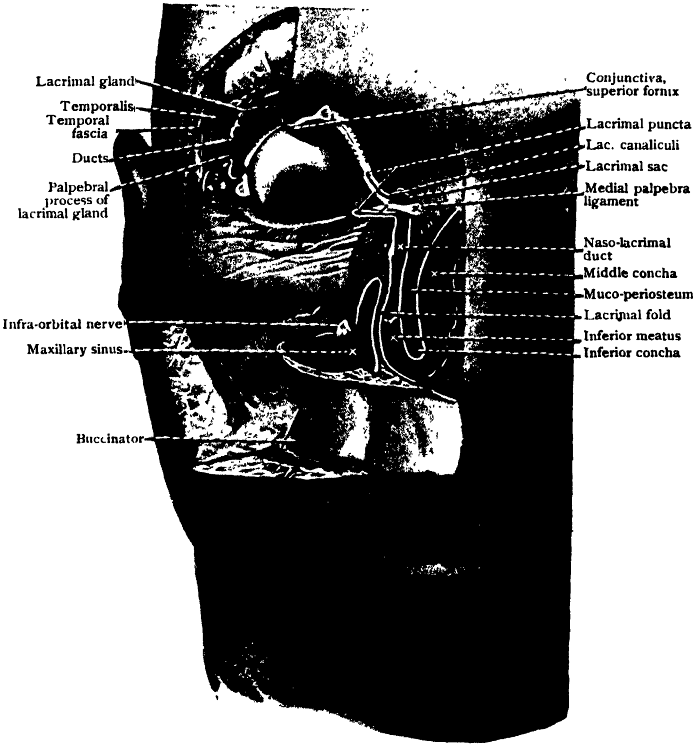


FIG. 12.—Dissection of Lacrimal Apparatus.

The *ducts* of the lacrimal gland—a dozen or less—are short and slender. They open on the lateral part of the upper lid near the superior fornix of the conjunctiva.

Conjunctiva.—The conjunctiva is a moist, transparent membrane covered with transparent stratified epithelium. It lines the deep surface of each eyelid; at the root of the eyelid, it is reflected on to the eyeball, forming a *fornix*, and covers the anterior part of the sclera. The conjunctiva as a whole is called the *conjunctival sac*, which is closed when the eye is shut. The cavity of the sac is the capillary interval between the ocular and palpebral conjunctiva and contains only enough lacrimal fluid to keep the surfaces moist. The cavity opens on to the exterior through the palpebral fissure, and communicates with the lacrimal sac through the canaliculi.

Lacrimal Canaliculi (Ductus Lacrimales).—These are the two slender tubes, less than half an inch in length, that lie in the medial part of the margins of the two eyelids. Each begins on the summit of a lacrimal papilla, where it appears as the black speck known as the *lacrimal punctum*. From the punctum, it runs medially to open into the lacrimal sac under cover of the medial palpebral ligament.

***Lacrimal* Sac.**—*The lacrimal sac lies in the lacrimal groove on the medial wall of the orbit, just within the medial orbital margin, behind the medial palpebral ligament. It is separated only by thin bone from the mucous membrane of* the nose, and, when it has to be operated on, the operator may prefer to approach it from the nose in order to avoid leaving a scar on the skin. The sac is about half an inch long and quarter of an inch wide. Its upper end is blind ; its lower end is continuous with the naso-lacrimal duct.

Naso-Lacrimal Duct.—This tube is about half an inch long, and of the same width as the sac (Fig. 12). It begins at the antero-medial corner of the floor of the orbit, and passes downwards and slightly backwards and laterally, through the naso-lacrimal canal, to end in a part of the cavity of the nose called the inferior meatus. At the medial side of its opening, the mucous membrane is pinched up to form the *lacrimal fold*, which acts as a flap valve to prevent the secretion of the nose from being driven up into the duct.

Lacrimal Fluid.—The liquid secreted by the lacrimal gland passes by the ducts of the gland into the conjunctival sac. It flows downwards over the eyeball and is carried also medially by the involuntary movements of the eyelids, which move towards the nose as well as towards each other ; that arrangement ensures that the whole front of the eye is moistened.

In ordinary circumstances, most of the fluid evaporates ; the residue is drained away by the lacrimal canaliculi into the lacrimal sac, whence the naso-lacrimal duct carries it to the nose. It is only when the secretion is excessive that it overflows as *tears*. When the lacrimal canaliculi and sac are extirpated, the patient therefore suffers little or no inconvenience from the overflow of tears unless the secretion is too abundant.

Accessory Lacrimal Glands.—The lacrimal gland may sometimes have to be removed. The conjunctiva is then kept moist by the increased activity of minute *accessory lacrimal glands* that lie near the fornices.

Complete the study of the face by an examination of the cartilages of the external nose.

Dissection.—**Strip the muscles and the remains of the skin off the nose and define the cartilages ; but preserve the nerves.**

Cartilages of External Nose.—The **upper nasal cartilage** (*C. nasi lateralis*) is triangular in outline. The upper part of the *anterior border* is fused with its fellow of the other side and with the anterior edge of the large cartilage of the septum of the nose ; but the lower part is separated from its fellow by a narrow interval in which the edge of the septal cartilage is seen. The *posterior border* is connected with the nasal bone and the frontal process of the maxilla. The *lower border* is attached by fibrous tissue to the lower cartilage.

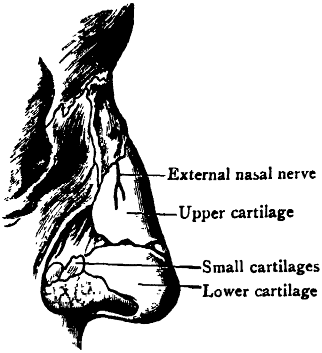


FIG. 13.—Cartilages of the External Nose.

The **lower nasal cartilage** (C. alaris major) is folded round the anterior part of the nostril. Its *medial part* lies in the lower part of the septum, and, with its fellow, forms the point of the nose. The *lateral part* is larger and is oval in shape. It reaches neither down to the margin of the nostril nor backwards to the maxilla. The interval behind it is filled with fatty fibrous tissue in which there are two or three islets of cartilage called the **small cartilages of the ala.**

Stitch the skin-flaps of the face together and also those of the anterior part of the scalp, in order to preserve the parts that have been exposed. see 42—

from · 26·

SIDE OF THE NECK

On the fifth day after the body is brought into the room and the second day after it is placed on its back, the dissectors *of the Head and Neck examine the side of the neck and begin the dissection of the posterior triangle.*

The side of the neck is bounded *below* by the clavicle, *above* by the lower border of the mandible, the mastoid portion of the temporal bone, and the superior nuchal line of the occipital bone. It extends *anteriorly* to the median plane, and *posteriorly* to the anterior border of the trapezius muscle. It is divided by the sterno-mastoid muscle into the *anterior* and *posterior triangles* of the neck.

Surface Anatomy.—Pull the head over towards the opposite side. The *sterno-mastoid* then raises up a wide, low ridge that extends from the manubrium and the medial third of the clavicle to the skull behind the ear. The sterno-mastoid is even more prominent in the living neck when the face is turned towards the opposite side; and on its surface, the *external jugular vein* can be seen if the superficial veins of the body are dilated; it descends almost vertically from the region below the auricle towards the clavicle.

Note the supraclavicular fossæ. The *lesser supraclavicular fossa* is a shallow depression, above the medial part of the clavicle, between the sternal and clavicular parts of the sterno-mastoid; it is opposite the lower part of the internal jugular vein. The *greater supraclavicular fossa*—both wider and deeper—is the depression above the intermediate third of the clavicle, and corresponds to the lower part of the posterior triangle; it overlies the cervical part of the brachial plexus and the third part of the subclavian artery.

POSTERIOR TRIANGLE

The dissection of the posterior triangle (except the brachial plexus) should be completed in two days. On the third day, the dissectors will study the parts exposed on the second day, and revise the parts cleaned and studied on the first day. On the fourth day—that is, the day before the body is turned face downwards—they will join forces with the dissectors of the Upper Limb and display and examine the brachial plexus.

When reflecting the skin, be very careful to remove nothing but the skin, for the superficial fascia is probably thin, and the *accessory nerve*—one of the most important structures in this region—is usually very near the skin though it is not in the superficial fascia. At a later stage in the dissection, a student often looks for this important nerve in vain, for it has been removed with the thin layers of fasciæ that adhered to the skin.

Dissection.—**Make an incision through the skin from the mastoid process along the middle of the sterno-mastoid muscle to the sternal end of the clavicle, and then along the clavicle to its acromial end. Reflect the flap from before backwards (together with the posterior flap of the scalp) till the anterior border of the trapezius is reached, and then leave it attached along that border.**

When the skin is reflected the superficial fascia and part of the platysma muscle will be exposed.

The *skin* is thicker over the upper and posterior part of the triangle than over the lower and anterior part.

The *superficial fascia* is usually thin, for, even in adipose bodies, the fat of the posterior triangle tends to accumulate under the deep fascia rather than in the superficial fascia.

The *platysma* is a long, wide, thin sheet of muscle that arises from the fasciæ and skin below the clavicle and sweeps upwards and forwards in the superficial fascia of the side of the neck to the face. Its upper part has been dissected in the face; it will be met again in the dissection of the anterior triangle. In the meantime, note that part of it lies in the superficial fascia of the lower and anterior part of the roof of the posterior triangle.

Dissection.—**Make an incision through the platysma along the line of the clavicle, and turn the muscle upwards and forwards. While making the incision and while reflecting the muscle, be careful not to injure the *supraclavicular nerves* and the *external jugular vein*, for they are directly subjacent to the platysma.**

Find the *external jugular vein* on the surface of the sterno-mastoid (Fig. 14), and trace it downwards till it pierces the deep fascia, and upwards till it is joined by the *posterior auricular vein*; clean that vein also.

Find the three cutaneous nerves that pierce the deep fascia on the surface of the sterno-mastoid near the middle of its posterior border and trace them—the *lesser occipital*, upwards along the posterior border of the sterno-mastoid; the *great auricular*, upwards towards the auricle; and the *anterior cutaneous nerve*, forwards across the sterno-mastoid.

Now, look for the three *supraclavicular nerves*—*lateral*, *medial*

and *intermediate*. They pierce the deep fascia at varying points above the clavicle. Trace them as they branch and radiate towards the corresponding thirds of the clavicle.

Then, clean the remains of the fat from the deep fascia.

Deep Fascia of Posterior Triangle.—The deep fascia is in two parts—the fascia of the roof and the fascia of the floor.

The *deep fascia of the roof* of the triangle is now displayed. It is part of the sheet of fascia that invests the whole neck. It stretches from the intermediate third of the clavicle to the superior nuchal line of the occipital bone ; and it is continuous, anteriorly, with the fascia of the sterno-mastoid, and, posteriorly, with the fascia of the trapezius. It is pierced by—(1) the supraclavicular nerves, (2) the external jugular vein, and (3) small unnamed cutaneous arteries. It is not *a strong layer, and it is frequently difficult to display it as a continuous sheet. Over the upper part of the triangle, it forms a single layer; but inferiorly it splits into two lamellæ —a superficial and a deep.*

The first or superficial layer is attached to the upper surface of the clavicle, and is continuous with the fascia on the superficial surface of the sterno-mastoid and trapezius. The second layer is continuous with the fascia on the deep surface of those muscles. Inferiorly, it passes down behind the clavicle to be attached to its lower border and to fuse with the fascia on the back of the subclavius muscle. Superiorly, as it ascends to join the first layer, it fuses with the fascia on the surface of the inferior belly of the omo-hyoid muscle (which lies a little above the clavicle—Fig. 15), and, by this means, it holds the omo-hyoid down in its place.

The space between those two layers of deep fascia extends upwards to the inferior belly of the omo-hyoid, or a little beyond it; laterally it reaches the coracoid process; and, anteriorly, if the handle of the knife is pushed forwards deep to the sterno-mastoid, the space is found to be continuous with the interval between the two layers of fascia in the front of the neck. Over the posterior triangle, the space contains :—(1) Part of the *external jugular vein* ; (2) the terminal part of the *transverse cervical vein* ; and (3) the *suprascapular vessels*, which, however, are behind the clavicle, between it and the second layer, rather than between the two layers of fascia.

The *accessory nerve* runs obliquely downwards and backwards across the middle of the triangle, enclosed in a tunnel in the deep fascia of the roof.

The *deep fascia of the floor* of the triangle is not yet displayed, but it is convenient to consider its connexions now. It clothes the muscles of the floor. Superiorly, it is attached to the superior nuchal line. Anteriorly or medially, it is continuous with the fascia of the upper part of the scalenus anterior muscle (p. 54) and with the prevertebral fascia which covers the muscles on the front of the cervical vertebræ. Posteriorly or laterally, it blends with the fascial sheaths of the deeper muscles at the back of the neck. Inferiorly, it extends downwards over the scalenus medius muscle behind the brachial plexus and the subclavian artery, and its looser, superficial part is continuous with the posterior wall of the axillary sheath; the plexus and the subclavian artery are covered anteriorly with a thin, indefinite layer prolonged over them from the loose areolar tissue that lies in front of the fascia of the scalenus anterior.

The structures between the fascia of the floor and the fascia of the roof are:—(1) A variable quantity of *fat*. (2) Some *lymph-glands*, along the posterior border of the sterno-mastoid and at the lower part of the triangle. (3) The *occipital artery*, at the apex of the triangle. (4) *Branches to the trapezius* (usually two) from the third and fourth cervical nerves, running obliquely downwards and backwards about the middle of the triangle. (5) The inferior belly of the *omo-hyoid*. (6) The *transverse cervical artery*, near the omohyoid. (7) The *nerve to the subclavius*, descending near the lower part of the posterior border of the sterno-mastoid.

Note that, in the lower part of the triangle, there are four layers of deep fascia. For the fascia of the roof splits into two layers to become continuous with the fascia on the two surfaces of the sterno-mastoid and trapezius; and the brachial plexus and subclavian artery have a loose layer in front of them and a more definite layer behind them.

Dissection.—**Trace the supraclavicular nerves upwards, through the deep fascia, to their common trunk at the posterior border of the sterno-mastoid; then, pull them aside, and cut through the first layer of the deep fascia immediately above the clavicle and along the posterior border of the sterno-mastoid, and turn it upwards. With the handle of the scalpel, explore the extent of the space between the two layers of fascia. Then, clear**

away the areolar tissue from the space, and expose and clean a further part of the *external jugular vein*, and the terminal parts of the *transverse cervical* and the *suprascapular veins* as they join the external jugular.

Be careful of the *nerve to the subclavius*, for it descends vertically near the lateral side of the external jugular vein (Figs. 16, 58); trace the nerve upwards and downwards.

Pull the lower part of the external jugular vein backwards and expose the *anterior jugular vein* as it joins the external jugular. Dissect carefully behind the clavicle and find the suprascapular vessels.

Trace the second layer of the deep fascia upwards till it fuses with the first layer, and note that it is continuous with the fascia around the inferior belly of the omo-hyoid.

Return to the middle of the posterior border of the sterno-mastoid, and identify the cutaneous nerves again. Trace them towards their origins under cover of the sterno-mastoid; but do so with great care, for the *accessory nerve* emerges from the sterno-mastoid at that point, and the lesser occipital nerve, as it curves upwards, hooks round the lower border of the accessory nerve—and that is a means of identifying the accessory nerve.

Cutaneous Branches of Cervical Plexus.—They are the lesser occipital, the great auricular, the anterior cutaneous nerve of the neck and the supraclavicular nerves. Only a small part of the anterior cutaneous nerve has been exposed, but, even at this stage, its further course can be understood. The great auricular and lesser occipital nerves have been traced to their terminations. The supraclavicular nerves have been traced as far as the clavicle, and their lower parts have been exposed by the dissectors of the Upper Limb.

The cervical plexus is formed by the anterior primary rami of the upper four cervical nerves, and lies under cover of the internal jugular vein and sterno-mastoid muscle in the upper part of the neck; its cutaneous branches emerge from under cover of the muscle at its posterior border, and diverge from one another—upwards, forwards, and downwards.

The **lesser occipital nerve** springs from the second cervical nerve. It emerges about the middle of the posterior border of the sterno-mastoid, and ascends for a short distance along its posterior border; it then passes to the superficial surface of the muscle, gives small branches to the skin of the neck, pierces the deep fascia, and divides into branches which supply the skin of the upper third of the cranial surface of the auricle, and a portion of the skin behind the auricle, where it communicates with the greater occipital nerve.

The **great auricular nerve** arises from the second and third cervical nerves. *It emerges immediately below the lesser* occipital nerve, turns round the posterior border of the sterno-mastoid, pierces the deep fascia and runs upwards and forwards, over the sterno-mastoid, towards the angle of the mandible—lying a little behind the external jugular vein, and nearly parallel to it, and giving small branches to the skin of the neck. It breaks up into three sets of terminal

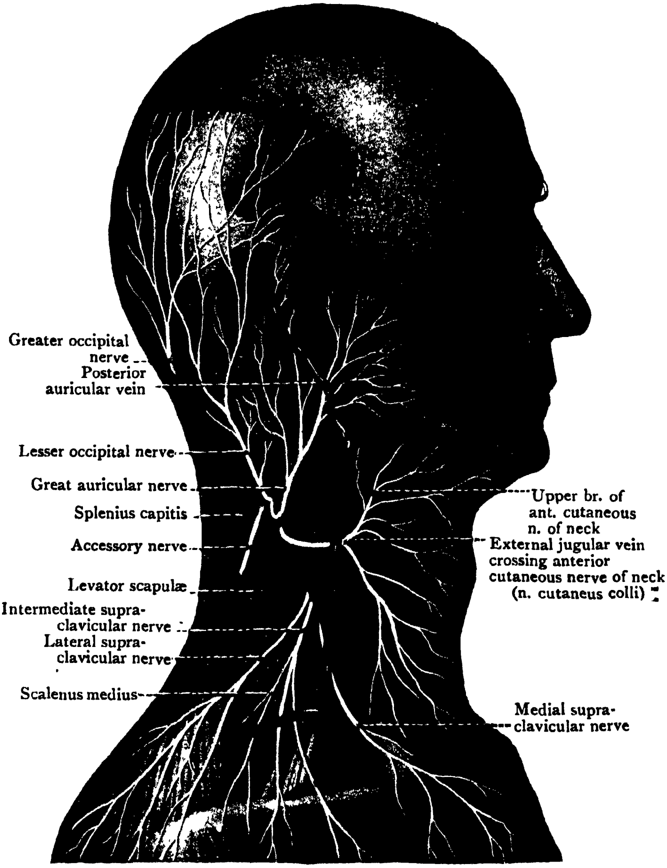

Greater occipital nerve
Posterior auricular vein
Lesser occipital nerve
Great auricular nerve
Splenius capitis
Accessory nerve
Levator scapulæ
Intermediate supra-clavicular nerve
Lateral supra-clavicular nerve
Scalenus medius
Upper br. of ant. cutaneous n. of neck
External jugular vein crossing anterior cutaneous nerve of neck (n. cutaneus colli)
Medial supra-clavicular nerve

FIG. 14.—Superficial Branches of Cervical Plexus.

branches—mastoid, auricular and facial. The *mastoid branches* go to the skin of the mastoid region. The *auricular branches* supply the skin of the lower part of both surfaces of the auricle. The *facial branches*, which have already been seen, ramify over the lower part of the masseter and the parotid gland. Some of the filaments enter the substance of the parotid gland to communicate with the facial and auriculo-temporal nerves.

The **anterior cutaneous nerve of the neck** (N. cutaneus colli) derives its fibres from the second and third cervical nerves, emerges with the great auricular, turns round the posterior border of the sterno-mastoid, pierces the deep fascia, passes forwards across the sterno-mastoid, either superficial or deep to the external jugular vein, under cover of the platysma, and divides into upper and lower branches, which ramify over the front of the neck, piercing the platysma to reach the skin ; the upper branch communicates freely with the cervical branch of the facial nerve. It supplies most of the skin of the side and the front of the neck.

The **supraclavicular nerves** arise from the junction of the third and fourth cervical nerves as a single trunk which emerges a little below the middle of the posterior border of the sterno-mastoid, and divides into three branches—the *lateral*, *intermediate* and *medial supraclavicular nerves*—which diverge from one another, and send small branches to the skin of the lower part of the side of the neck. The medial nerve pierces the deep fascia at the posterior border of the sterno-mastoid a little above the clavicle, and divides into branches which descend over the medial third of the clavicle to supply the skin of the front of the chest down to the level of the sternal angle. The intermediate nerve pierces the deep fascia a little above the middle of the clavicle, and sends branches down to the same level. The lateral nerve pierces the fascia at a slightly higher level ; its branches descend over the lateral third of the clavicle to supply the skin over the upper half of the deltoid muscle.

JUGULAR VEINS.—There are three pairs of jugular veins—anterior, external and internal. The *internal jugular vein* is much the largest and is the most important, but it is under cover of the sterno-mastoid and other structures and will not be dissected till the deeper structures of the neck are examined. The *anterior jugular vein* runs downwards in the superficial fascia near the middle line of the front of the neck and then turns laterally under cover of the sterno-mastoid to reach the external jugular vein. Though it runs most of its course in the superficial fascia, it is not conspicuous, for it is very slender.

External Jugular Vein.—This is the jugular vein with which the dissectors are familiar before they begin to dissect, for it is a fairly large vein that lies in the superficial fascia for most of its course, and is often conspicuous in the living neck.

Origin, course and termination.—It begins on the surface of the sterno-mastoid, below the lower end of the parotid gland, by the union of the posterior auricular vein and the posterior branch of the posterior facial vein. After its formation, it runs downwards over the sterno-mastoid, and reaches the posterior border of the muscle about an inch above the clavicle. There, it pierces the first layer of deep fascia, and then descends between the first and second layers close to the sterno-mastoid; finally, it pierces the second layer to end in the subclavian vein behind the clavicle (Figs. 15 and 58). After it pierces the deep fascia, it occasionally inclines medially, deep to the sterno-mastoid, to terminate in the subclavian vein near the internal jugular, or in the internal jugular.

Relations and tributaries.—As the external jugular vein lies on the sterno-mastoid, it is at first parallel with and anterior to the great auricular nerve, and then deep to the platysma; and while beneath the platysma it crosses either superficial or deep to the anterior cutaneous nerve of the neck (Fig. 15). Between the two layers of the deep fascia, it receives the transverse cervical, suprascapular and anterior jugular veins: and it lies superficial to the lower roots of the brachial plexus. As it pierces the second layer of deep fascia, it is superficial to the third part of the subclavian artery.

Immediately above its termination the vein is provided with a valve. As it pierces the first layer of the deep fascia, its wall is closely connected with the margin of the opening through which it passes. Consequently, when the fascia is stretched the lumen of the vein is widened, and, if the vein is divided at that point in the living person, the walls of the lower portion do not collapse and air is apt to be sucked into it when the breath is drawn—an accident which may be fatal.

The contents of the posterior triangle must now be exposed and cleaned. Remove all the deep fascia and the fat from the triangle. As you do so, remove also the lymph-glands : they lie along the posterior border of the sterno-mastoid and in the lower part of the triangle. But preserve the other structures.

Dissection.—Begin at the apex of the triangle. Clean the *occipital artery*, which usually crosses the apex ; and then remove the fat and fascia from the muscles in the upper half of the floor.

Now, go back to the middle of the posterior border of the sterno-mastoid. Find the *accessory nerve* again, and trace it across the triangle to the trapezius. Find also the branches that run from the third and fourth cervical nerves to the trapezius near the accessory nerve ; one of them may be mistaken for it. At the same time, find two small nerves that arise from the third and fourth cervical nerves, and sink into one of the muscles of the floor of the triangle—the levator scapulæ.

Turn next to the *inferior belly of the omo-hyoid*. Cut through the fascia along its upper border and reflect the fascia downwards ; turn the upper border of the muscle towards you, and find its nerve, which enters its deep surface near the sterno-mastoid.

The dissector will now trace and clean the structures that lie between the accessory nerve and the omo-hyoid.

Dissection.—(1) Begin with the upper part of the *brachial plexus* ; as you clean it, be careful of the nerves that spring from it.

(2) The *suprascapular nerve*—a fairly thick nerve that runs downwards and backwards immediately above the plexus, and is partly under cover of the omo-hyoid.

(3) A little higher up, find a slender nerve called the *nerve to the rhomboids* ; it runs downwards and backwards and disappears through the floor of the triangle.

(4) The *transverse cervical artery* appears at the upper border of the omo-hyoid. Follow it backwards till it disappears.

(5) Turn the upper part of the brachial plexus forwards, and find the upper roots of the *nerve to the serratus anterior*, which spring from the back of the plexus and run downwards under cover of it.

(6) The *nerve to the subclavius* has been cleaned already ; identify it again.

Lastly, deal with the structures below the omo-hyoid.

Dissection.—(1) Remove the terminal parts of the *suprascapular* and *transverse cervical veins*, if they are in the way.

(2) Pull up the *suprascapular artery* from behind the clavicle, and clean it.

(3) Remove the *second layer of deep fascia*.

(4) Clean the small part of the transverse cervical artery that lies behind that fascia, below the omo-hyoid.

(5) Pick up the *nerve to the subclavius* again, and follow it to its termination.

(6) Clean the lowest part of the *external jugular vein*.

(7) Remove a third layer of deep fascia—a layer which clothes the front of the brachial plexus and the third part of the subclavian artery and the subclavian vein.

(8) Clean the *subclavian vessels* and the part of the *brachial plexus* that lies near them.

(9) Raise the lateral part of the plexus, and find the *nerve to the serratus anterior* under cover of it, and follow the nerve upwards and downwards.

Boundaries and Contents of Posterior Triangle.—The triangle is bounded *in front* by the sterno-mastoid; *behind* by the trapezius; *below* by the intermediate third of the clavicle; and *above* by the superior nuchal line of the occipital bone, or by the meeting of the upper ends of the sterno-mastoid and the trapezius.

The *roof* is the deep fascia, covered by superficial fascia and skin, and, in its lower and anterior part, by the platysma, which is embedded in the superficial fascia. The roof is pierced by—(1) the external jugular vein, near the lower and anterior angle; (2) the supraclavicular nerves, a short distance above the clavicle; (3) small unnamed cutaneous arteries; (4) lymph-vessels, passing from the superficial structures to the glands in the triangle.

The *floor* is formed of muscles, clothed with deep fascia. From above downwards, the muscles are the splenius capitis, the levator scapulæ and the scalenus medius. Often, the upper end of the semispinalis capitis forms the floor at the apex of the triangle; and, sometimes, the first digitation of the serratus anterior appears in the lower posterior angle—especially on the right side, as the right serratus is often bigger than the left.

The contents of the posterior triangle are :—

1. Fatty areolar tissue.
2. Inferior belly of omo-hyoid muscle.
3. Lymph-glands.
4. Arteries
   - Occipital (usually).
   - Third part of subclavian.
   - Transverse cervical and its terminal branches.
   - Suprascapular (behind clavicle).
5. Veins
   - Subclavian (behind clavicle).
   - External jugular. (p. 49)
   - Transverse cervical.
   - Suprascapular.
   - Termination of anterior jugular.

6. Nerves	Accessory.		
	Lesser occipital.	(p. 46)	Branches of the cervical plexus.
	Great auricular.	(p. 46)	
	Anterior cutaneous nerve of neck.	(p. 48)	
	Supraclavicular.	(p. 48)	
	To levator scapulæ.		
	To trapezius.		
	To inferior belly of omo-hyoid, from ansa hypoglossi.		
	Trunks of brachial plexus.		
	Nerve to the rhomboids.		Branches of the brachial plexus.
	Nerve to the serratus anterior.		
	Suprascapular.		
	Nerve to the subclavius.		

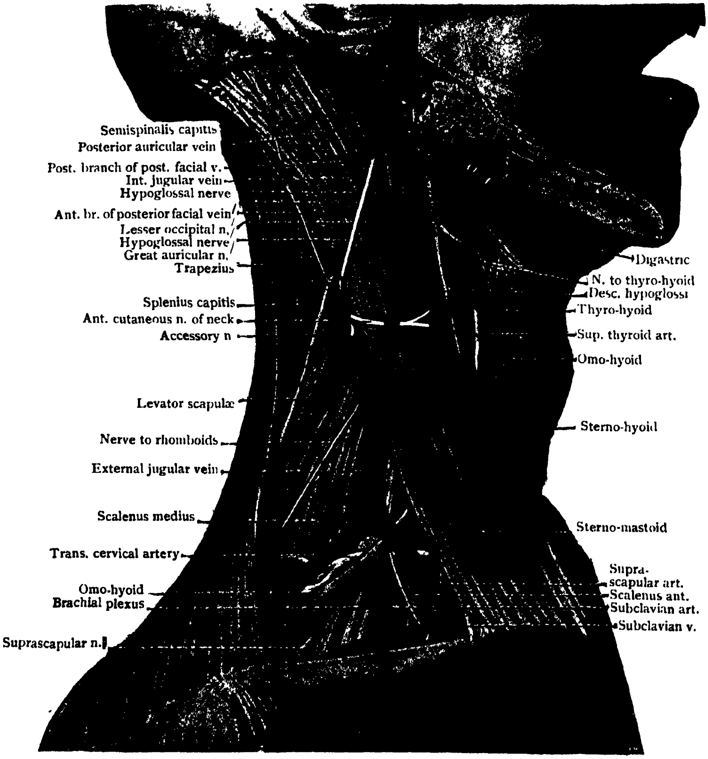


FIG. 15.—Triangles of the Neck seen from the side. The clavicular head of the sterno-mastoid muscle was small, and a considerable part of the scalenus anterior muscle is therefore seen.

The *external jugular vein* has been described already (pp. 42, 49). The *occipital artery* merely crosses the apex of the triangle; the part of it in the triangle is therefore so short that, at this stage, it is necessary only to note its presence there. The *suprascapular artery* and the *subclavian vein* are behind the clavicle; but it is convenient to describe them with the contents of the triangle.

Accessory Nerve.—The portion of the accessory nerve which appears in the posterior triangle consists of fibres which arise from the cervical part of the spinal cord. Before appearing in its present situation, this portion entered the cranium through the foramen magnum and left it by passing through the jugular foramen; having escaped from the skull, it descended vertically for nearly an inch, and then passed downwards and backwards, through the deeper fibres of the sterno-mastoid—supplying it.

The nerve enters the posterior triangle at or a little above the middle of the posterior border of the sterno-mastoid. It runs downwards and backwards, through a tunnel in the deep fascia of the roof of the posterior triangle, parallel to the fibres of the levator scapulæ, from which it is usually separated by a quantity of fat; and it disappears under the trapezius about two inches above the clavicle. It ramifies on the deep surface of the trapezius, supplying it—the main branch descending to the lower end of the muscle. As it enters the triangle, the lesser occipital nerve turns round its lower border. One of the branches to the trapezius from the third and fourth cervical may be thick enough to be mistaken for the accessory nerve; but, though these nerves run in the same direction as the accessory and are near it, they are in a deeper plane amidst the fat of the triangle.

Branches of Cervical Plexus.—The only branches of the cervical plexus which appear in the posterior triangle are: (1) The *cutaneous branches*, studied already (pp. 46, 48). (2) Two small *branches to the levator scapulæ* from the third and fourth cervical nerves which enter the muscle opposite the middle of the posterior border of the sterno-mastoid. (3) The *branches to the trapezius* from the third and fourth cervical nerves; they communicate with the accessory nerve, both in the triangle and under cover of the trapezius.

Before the remaining contents of the posterior triangle are studied, expose the scalenus anterior muscle. It lies under cover of the sterno-mastoid, and therefore does not belong to the posterior triangle ; and, at a later period, it will be examined fully with the other scalene muscles ; but make a preliminary examination of it now, for, in the root of the neck, it is a guide-post to which reference has to be made in the description of other structures.

***Dissection.*—Cut through the clavicular attachment of the sterno-mastoid close to the clavicle, and reflect that part of the muscle forwards. Remove the underlying fat till the *scalenus anterior* is exposed. Then, define the borders of the muscle and clean the structures on its surface, namely, *omo-hyoid, transverse cervical artery, suprascapular artery, anterior jugular vein, subclavian vein* and *phrenic nerve.* Depress the clavicle to reach the subclavian vein.**

Scalenus Anterior.—This important muscle takes origin from the transverse processes of the third, fourth, fifth and sixth cervical vertebræ, and descends, tapering, to be inserted into the first rib. It lies in front of the cervical pleura, and crosses in front of the subclavian artery (second part). It is concealed by the sterno-mastoid. The phrenic nerve descends over the front of the muscle ; it lies between the muscle and its fascia and crosses the muscle gradually from lateral to medial border. Superficial to that, the muscle is crossed by the inferior belly of the omo-hyoid, the transverse cervical artery, the suprascapular artery, the anterior jugular vein, and the subclavian vein—named in order from above downwards. The anterior primary rami of the cervical nerves, from the fourth downwards, emerge at the lateral border of the muscle.

Inferior Belly of Omo-Hyoid.—This slender muscle springs from the upper border of the scapula and the suprascapular ligament under cover of the trapezius, and passes upwards to enter the posterior triangle at its lower and posterior angle ; it then runs upwards and forwards, across the brachial plexus (at a variable distance from the clavicle) to the sterno-mastoid, crosses the scalenus anterior, and joins the tendon which connects it with the superior belly. The tendon lies under cover of the sterno-mastoid, on the internal jugular vein, at the level of the cricoid cartilage. As the inferior belly crosses the posterior triangle, it lies superficial to the suprascapular nerve, the transverse cervical artery and the brachial plexus. The muscle can be felt through the skin and the fasciæ in the living person by the finger moved up and down a little above the clavicle; and, in a thin person who is talking, the twitching of the muscle can be seen.

Its nerve reaches its deep surface by running along the back of the intermediate tendon, and comes from a nerve loop, called the *ansa hypoglossi*, which lies on the common carotid artery, and will be dissected later. Cervicalis

Third Part of Subclavian Artery.—The right subclavian artery springs from the innominate artery behind the right sterno-clavicular joint. The left artery springs from the arch of the aorta, and ascends to enter the neck behind the left sterno-clavicular joint. On each side, it arches laterally in the root of the neck across the front of the cervical pleura, and ends at the outer border of the first rib by becoming the axillary artery. The scalenus anterior descends in front of the highest part of the arch. As the relations of the subclavian artery are very numerous, use is made of the scalenus anterior to divide the artery (for descriptive purposes) into three parts—the first part medial to scalenus anterior, the second part behind it, and the third part lateral to it.

The third part is the only part with which we have to deal at present. It begins about a finger's breadth above the clavicle at the lateral border of the scalenus anterior (which is opposite the posterior border of the sterno-mastoid); and it slopes rapidly to its termination at the outer border of the first rib opposite the lower border of the middle of the clavicle. Its distal part is behind the clavicle, and is therefore below the posterior triangle; but it is convenient to deal with it as a whole.

Usually the third part of the subclavian artery gives off no branch; but occasionally it gives origin to the *descending scapular artery*, which takes the place of the deep branch of the transverse cervical artery.

Relations.—Postero-inferior: cervical pleura; lower end of the scalenus medius; lowest trunk of the brachial plexus, between the artery and scalenus medius; the first rib, below and in front of scalenus medius. In the living person the artery can be compressed against the first rib. *Superficial*: (1) Skin. (2) Superficial fascia, platysma and intermediate supraclavicular nerve. (3) First layer of deep fascia and the clavicle. (4) Suprascapular artery and vein, behind the clavicle; external jugular and transverse cervical veins, *and, often, another suprascapular vein, above the clavicle.* (5) Second layer of deep fascia. (6) Nerve to subclavius. (7) Third layer of deep fascia. The suprascapular and transverse cervical veins are connected by cross branches with each other, forming a troublesome network in front of the artery.

Subclavian Vein.—The subclavian vein is wholly behind the clavicle; but it is convenient to study it now. It is the continuation of the axillary vein. It begins at the outer border of the first rib, runs medially and slightly upwards, and ends at the medial border of the scalenus anterior by joining the internal jugular vein to form the innominate vein. It corresponds therefore to the third and second parts of the artery.

It lies on the first rib in front of the scalenus anterior —which separates it from the second part of the artery. It is therefore in front of the artery; but, owing to the slope of the rib, it is at a lower level. Anterior to it, there are the clavicle, the nerve to the subclavius, and the subclavius muscle itself. Its sheath is attached to the fascia on the back of the subclavius. That connexion is of some practical importance; a forward movement of the clavicle drags upon the vein; and, when such a movement is made when the vein is wounded, there is danger of air being sucked into the vein.

The subclavian vein has only one tributary, and that is the external jugular vein, which joins it at the lateral margin of the scalenus anterior. It has one valve—placed on the distal side of the entrance of the external jugular.

Suprascapular and Transverse Cervical Vessels.—The two arteries arise, under cover of the internal jugular vein and the sterno-mastoid, at the medial margin of the scalenus anterior. They spring from a short, wide branch of the first part of the subclavian artery, called the *thyro-cervical trunk*, which gives off the inferior thyroid artery also.

The **transverse cervical artery** crosses the scalenus anterior and the phrenic nerve, and, having escaped from under cover of the sterno-mastoid, it crosses the posterior triangle to end at the anterior border of the levator scapulæ by dividing into deep and superficial branches. In the triangle, it is superficial to the nerve to the subclavius, the upper trunks of the brachial plexus and the suprascapular nerve; and the inferior belly of the omo-hyoid crosses it near the sterno-mastoid.

Its terminal branches will be traced by the dissectors of the Upper Limb. The *superficial branch* passes superficial to the levator scapulæ, and ramifies on the deep surface of the trapezius ; the *deep branch* descends, deep to the levator and the rhomboids, along the medial margin of the scapula.

Occasionally, the transverse cervical artery is small and is spent in the trapezius, and is then called the *superficial cervical artery*. In such a case, an artery called the *descending scapular* springs from the third part of the subclavian, and takes the place of the deep branch.

The **suprascapular artery** (A. transversa scapulæ) runs laterally and downwards, under cover of the sterno-mastoid, across the scalenus anterior and the phrenic nerve, and then laterally behind the intermediate third of the clavicle, in front of the subclavian artery, towards the posterior angle of the triangle. There, it joins the suprascapular nerve and descends to the scapula. Behind the clavicle, it is closely accompanied by one or two veins ; and another suprascapular vein often runs a parallel course a little above it.

The main *suprascapular* and *transverse cervical veins* end in the external jugular ; the arteries are therefore accompanied only by very slender venules as they cross the scalenus anterior.

The dissectors should have completed the posterior triangle by the end of the fourth day after the body has been placed on its back—all except the *brachial plexus*. They will now join the dissectors of the Upper Limb in displaying and studying the brachial plexus and the branches that spring from it in the neck.

In order to expose the plexus, you will require to dissect and examine the *sterno-clavicular joint*, and to displace the clavicle. The joint belongs equally to the dissectors of Head and Neck and of Upper Limb. It is described in Vol. I., and the steps of the dissection to expose the joint and to complete the exposure of the brachial plexus are given there. Dissect and examine the joint with the dissectors of the Upper Limb, and then proceed, with them, to the study of the plexus.

BRACHIAL PLEXUS

Position and Arrangement.—The brachial plexus lies in the lower part of the posterior triangle, behind the clavicle, and in the upper part of the axilla. The portion of the plexus that lies behind the clavicle varies with the position of the body, for the clavicle is nearly horizontal in the standing and sitting position, while, in the recumbent position, its lateral end is considerably higher than the medial end. The plexus begins, by the union of roots, at the lateral margin of the scalenus anterior, opposite the lower third of the posterior border of the sterno-mastoid; it ends, by breaking up into the large nerves of the upper limb, at the junction of the second and third parts of the axillary artery, opposite the infero-lateral margin of the pectoralis minor, about a finger's breadth below and medial to the tip of the coracoid process.

The parts of the plexus are roots, trunks, divisions, cords, and branches. (See Fig. 18, p. 46, Vol. I.)

The **roots** of the plexus are the anterior primary rami of the lower four cervical and first thoracic nerves, with small contributions from the fourth cervical and second thoracic. The roots form three trunks (upper, middle and lower) thus :—The fifth and sixth nerves, and the twig from the fourth, unite to form the **upper trunk.** The seventh alone forms the **middle trunk.** The eighth cervical and first thoracic, with the twig from the second thoracic, unite to form the **lower trunk.**

Each of the three trunks divides into an anterior and a posterior division. The division is not quite equal, and very few of the fibres of the first thoracic nerve pass into a posterior division. These divisions are rearranged to form the three cords of the plexus—lateral, medial and posterior. The three posterior divisions unite to form the **posterior cord.** The upper two anterior divisions unite to form the **lateral cord.** The lower anterior division becomes the **medial cord.**

Relations.—In the neck, the plexus is closely related, *posteriorly*, to the fascia of the scalenus medius, the lower trunk lying above the first rib between the scalenus medius and the subclavian artery. The roots of the nerve to the serratus anterior descend under cover of the plexus, between it and the scalenus medius.

Anteriorly, a large number of structures intervene between the plexus and the skin :—(1) The superficial fascia containing the platysma and the intermediate supraclavicular nerves. (2) The first layer of deep fascia and the clavicle. (3) The external jugular vein, the transverse cervical vein, and the suprascapular veins and artery. (4) The second layer of deep fascia. (5) The inferior belly of the omo-hyoid, the transverse cervical artery, and the nerve to the subclavius. (6) The third layer of deep fascia. (7) The third part of the subclavian artery.

In the axilla, the cords are first placed close together

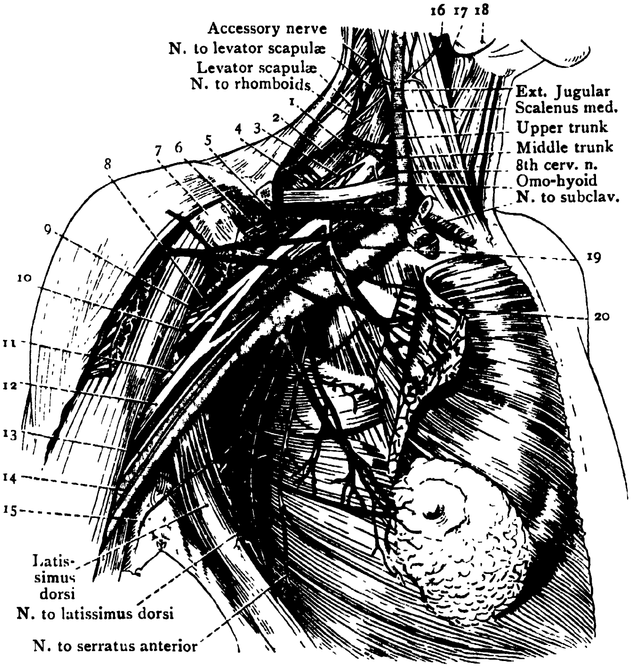


FIG. 16.—Dissection to show the General Relations of the Brachial Plexus.

1. Nerve to serratus anterior.
2. Scalenus medius.
3. Suprascapular nerve.
4. Serratus anterior.
5. Upper subscapular nerve.
6. Subscapularis.
7. Pectoralis minor.
8. Nerve to coraco-brachialis.
9. Circumflex nerve.
10. Musculo-cutaneous nerve.
11. Radial nerve.
12. Median Nerve.
13. Medial cutaneous nerve of forearm.
14. Medial cutaneous nerve of arm.
15. Intercosto-brachial nerve.
16. Internal jugular vein.
17. Superior thyroid artery.
18. Submandibular gland.
19. Lateral pectoral nerve.
20. Medial pectoral nerve.

above, behind and lateral to the first part of the axillary artery, and then are grouped round the second part in the positions indicated by their names—lateral, medial, posterior. The further relations in the axilla are given in Vol. I.

Branches.—The branches of the plexus arise from the roots in the neck and from the cords in the axilla.

The roots receive communicating branches from the sympathetic trunk, and they give off muscular branches. *Grey rami communicantes* pass from the middle cervical ganglion of the sympathetic trunk to the fifth and sixth nerves; from the inferior ganglion to the seventh and eighth nerves; from the first thoracic ganglion to the first thoracic nerve. The *muscular branches* are: (1) Twigs to the scalene muscles and to the prevertebral muscle called the longus cervicis; (2) a root of the phrenic nerve from the fifth; (3) four nerves which supply muscles of the upper limb, namely, the suprascapular nerve, the nerve to the rhomboids, the nerve to the subclavius, and the nerve to the serratus anterior. The dissector of the Head and Neck will examine those four nerves in the cervical part of their course. (See below.)

Each cord gives off one or more collateral branches and then divides into two terminal branches at the junction of the second and third parts of the axillary artery. The *lateral cord* gives off the lateral pectoral nerve (N. thoracalis anterior lateralis) and divides into the musculo-cutaneous nerve and the lateral root of the median nerve. The *medial cord* gives off the medial pectoral nerve (N. thoracalis anterior medialis), the medial cutaneous nerves of the arm and forearm, and divides into the ulnar nerve and the medial root of the median nerve. The *posterior cord* gives off the two subscapular nerves and the nerve to the latissimus dorsi, and divides into the radial nerve and the circumflex nerve (N. axillaris). The branches of the cords are traced by the dissectors of the Upper Limb.

The **nerve to the rhomboids** (N. dorsalis scapulæ) springs from the back of the fifth cervical nerve, runs laterally and downwards, a little above the brachial plexus, either on the surface of the scalenus medius or among its superficial fibres, leaves the posterior triangle between the borders of the scalenus medius and levator scapulae, and descends deep to (*i.e.* in front of) the levator and the two rhomboids, and supplies all three.

The **nerve to the subclavius** is a slender nerve that arises at the point where the fifth and sixth cervical nerves unite to form the upper trunk of the plexus; and it derives its fibres either from both nerves or from the fifth alone. It runs downwards near the scalenus anterior, in front of the brachial plexus and the subclavian vessels, to enter the back of the subclavius muscle. It is lateral to the external jugular vein, behind the omo-hyoid muscle, the transverse cervical and suprascapular vessels and the clavicle. It frequently sends a branch on to the surface of the scalenus anterior to join the phrenic nerve ; this branch replaces the root of the phrenic from the fifth.

The **suprascapular nerve** arises from the fifth and sixth cervical nerves at their junction. It runs downwards and backwards, on the scalenus medius, immediately above the brachial plexus, and partly under cover of the inferior belly of the omo-hyoid. Reaching the posterior angle of the triangle, it falls in with the suprascapular artery, and descends with it to the scapula to supply the supraspinatus and infraspinatus muscles and the shoulder joint.

The **nerve to the serratus anterior** (N. thoracalis longus) arises by three roots from the back of the fifth, sixth and seventh nerves; in their course in the neck, these roots are hidden behind the brachial plexus. The roots from the fifth and sixth nerves descend through the substance of the superficial part of the scalenus medius, and, emerging from it near its lateral border, unite to form one stem which descends into the axilla between the upper border of the serratus anterior and first part of the axillary artery. The root from the seventh descends over the surface of the scalenus medius, crosses the upper border of the serratus close by the medial side of the other part and joins it in the axilla.

***Dissection.*—After the brachial plexus and its cervical branches have been examined, replace the clavicle ; replace also the skin-flap reflected from the posterior triangle and fix it in position by a few sutures.**

DISSECTION OF THE BACK

On the ninth day after the body is brought into the room—that is, on the sixth day after it has been placed on its back—it will be turned on its face, with the thorax and the pelvis supported by blocks. The body will remain on its face for five days, and during that period the dissectors of the Head and Neck will complete the dissection of the posterior part of the scalp (if that was deferred—p. 13), will dissect the back and the suboccipital region, and will remove and examine the spinal cord.

Join the dissectors of the Upper Limb in studying the *surface anatomy* of the back, which is described in Vol. I.; and then proceed with them to reflect the skin.

Dissection.—Make a median incision from the external occipital protuberance to the seventh cervical spine, and a second incision laterally from the seventh cervical spine to the acromion, and reflect the flap. The posterior triangle can now be seen from behind; and the dissector should note the position of its contents and the muscles of its floor from that point of view.

Clean the *occipital belly* of the occipito-frontalis, if that has not been done already. Afterwards, look for the cutaneous nerves in the superficial fascia over the upper part of the trapezius. If the *greater occipital nerve* was not found during the dissection of the scalp, secure it now, as it pierces the deep fascia about an inch lateral to the external occipital protuberance; trace it upwards through the superficial fascia of the scalp, and clean the branches of the *occipital artery*. Find the *third occipital nerve* in the superficial fascia between the greater occipital and the median plane. Trace it upwards to its termination, and downwards to the point where it pierces the deep fascia.

At a still lower level, look for the cutaneous branches of the posterior primary rami of the other cervical nerves. They are variable in number and position, but those which are present will be found piercing the deep fascia a short distance from the median plane, and running downwards and laterally.

Then, clean the surface of the trapezius.

The portions of the occipital artery and nerves found here are described on pp. 17, 18, 19.

FIRST LAYER OF MUSCLES.—The trapezius and latissimus dorsi constitute the first layer of the muscles of the back. Only that part of the trapezius which lies above the level of the seventh cervical spine belongs to the dissector of the Head and Neck; the lower part and the latissimus must be cleaned by the dissector of the Upper Limb, but the dissector of the Head should examine the whole origin and insertion of the trapezius.

Trapezius.—The trapezius arises from the medial third of the superior nuchal line, the external occipital protuberance, the posterior border of the ligamentum nuchæ, the seventh cervical spine, the tips of all the thoracic spines and the corresponding supraspinous ligaments.

In the region of the seventh cervical spine, the origin is more aponeurotic than elsewhere, and the fine tendinous fibres of the muscles of the two sides form an ovoid aponeurotic area some two inches in length.

The upper fibres of the muscle descend in oblique curves and are inserted into the lateral third of the clavicle; the middle fibres run horizontally towards the shoulder, and are inserted into the acromion and the crest of the spine of the scapula. The lower fibres ascend, and terminate in a small triangular tendon which plays over the smooth triangle at the root of the scapular spine before insertion into its crest.

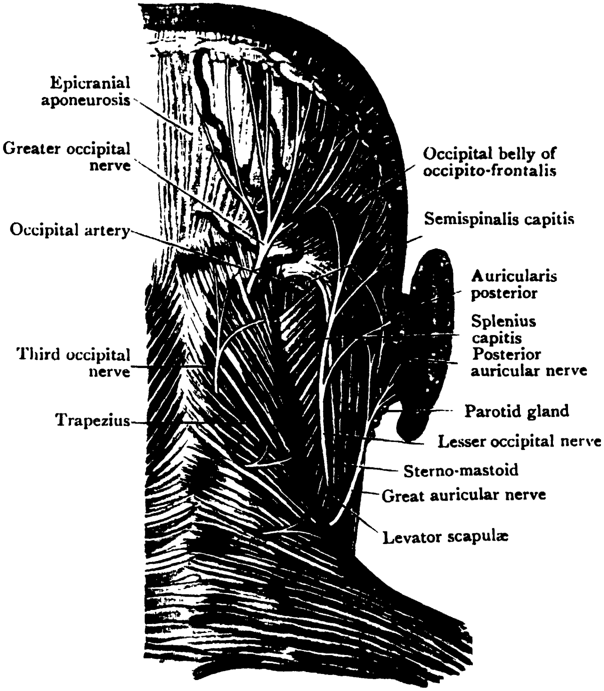


FIG. 17.—Superficial Dissection of Back of Neck.

The muscle is supplied by the accessory and the third and fourth cervical nerves. The whole muscle acting (or the middle fibres alone), it draws the scapula medially and braces the shoulder backwards; the upper part of the muscle acting alone raises the tip of the shoulder; the lower part depresses the scapula and rotates it so that the glenoid cavity is turned upwards in the movement of raising the upper limb above the head.

Dissection.—On the second day after the body has been placed on its face, the dissectors, in conjunction with the dissectors of the Upper Limb, must reflect the _trapezius_ muscle.

Separate the muscle from the occipital bone, divide it about half an inch from the spines of the vertebræ, and then throw it towards its insertion. On its deep surface, the _accessory nerve_, the _branches from the third and fourth cervical nerves_ and the _superficial branch of the transverse cervical artery_ will be noticed. The dissectors of the Upper Limb clean these structures, but the dissectors of the Head and Neck will trace the artery to its origin.

Define also attachments of the _levator scapulæ_. Find the _deep branch of the transverse cervical artery_ and the _nerve to the rhomboids_ again on the deep surface of the muscle, and secure the twigs which the nerve gives to the levator scapulæ. Examine the origin of the _inferior belly of the omo-hyoid_ (p. 54), and note the relation of the suprascapular ligament to the _suprascapular vessels_ and _nerves_.

SECOND LAYER OF MUSCLES.—The levator scapulæ, rhomboidei, serrati posteriores and splenius are classed as muscles of the second layer. The rhomboids and the lower part of the levator belong to the dissectors of the Upper Limb, the remaining muscles to the dissectors of the Head and Neck.

Levator Scapulæ.—The levator scapulæ arises by four slips from the transverse processes of the upper four cervical vertebræ. The slips unite to form an elongated muscle which extends downwards and backwards to be inserted into the medial border of the scapula from the upper angle to the spine. The muscle is cleft lengthwise into two parts ; and the uppermost fibres of origin are the lowest at the insertion. The nerve-supply is derived from the third and fourth cervical nerves, and also from the nerve to the rhomboids. The muscle raises the scapula and draws it towards the vertebral column.

The *second day's* work on the back is now completed. On the *same day*, the dissectors of the Upper Limbs must finish their share of the dissection of the back, so as to allow the dissectors of the Head and Neck to begin the examination of the deeper structures of the back.

Three days are allowed for the dissection of the deeper structures. During the first two days, dissect and study the muscles, fasciæ, vessels and nerves. The third day is devoted to the vertebral canal and the spinal cord,

Dissection.—**Clean the *posterior serrate* muscles. They are two in number, superior and inferior. The *superior* has been exposed by the removal of the trapezius and the rhomboids, and the *inferior* by the removal of the latissimus dorsi.**

Serrati Posteriores.—The posterior serrate muscles are two thin sheets—partly fleshy, partly aponeurotic—that lie on the back of the thorax.

The *serratus posterior superior* passes downwards and laterally from the seventh cervical spine and the upper two or three thoracic spines to the second, third, fourth and fifth ribs ; and it raises these ribs. It is supplied by the second, third and fourth intercostal nerves.

The *serratus posterior inferior* arises from the lumbar fascia opposite the upper two lumbar spines and lower two thoracic spines, and passes upwards and laterally to be inserted into the lower four ribs. It is encountered in an operation on the kidney through the loin. It fixes the lower ribs where the diaphragm contracts; and it is supplied by the lower intercostal nerves and the subcostal nerve.

After the posterior serrate muscles have been examined the dissectors of the Head and Neck should associate themselves with the dissectors of the Abdomen in the examination of the lumbar fascia.

Lumbar Fascia.—The lumbar fascia is a membranous sheet, almost aponeurotic in character, not limited to the lumbar region (as the name suggests) but also extending downwards over the muscles on the back of the sacrum and upwards over the back of the thorax to the neck. It is thin in the thoracic portion of its extent, but thick and strong in the lumbar and sacral regions. In all three regions it binds down the deeper muscles of the back to the sides of the spines and to the transverse processes of the vertebræ.

The *thoracic part* is a thin, transparent lamina which extends from the tips of the spines and the supraspinous ligaments to the angles of the ribs. At the upper end of the thoracic region, it dips beneath the serratus posterior superior and extends into the neck ; at the lower end, it blends with the aponeurosis of origin of the serratus posterior inferior, and, through that, becomes continuous with the posterior layer of the lumbar portion of the fascia.

The *lumbar part* is separable into three lamellæ — a posterior, a middle, and an anterior.

The anterior and middle layers enclose the quadratus lumborum muscle, which lies alongside the lumbar transverse processes ; and the two layers are attached to these processes. Laterally, they unite together at the lateral margin of the quadratus, and give origin to part of the transversus abdominis. The posterior layer is by far the strongest, and covers the sacro-spinalis—*i.e.* the great mass of muscle in the loin. It is attached medially to the lumbar spines ; laterally, it blends with the back of the middle layer at the lateral margin of the sacro-spinalis ; and, beyond their line of fusion, the middle layer gives origin to the uppermost part of the internal oblique muscle of the abdomen.

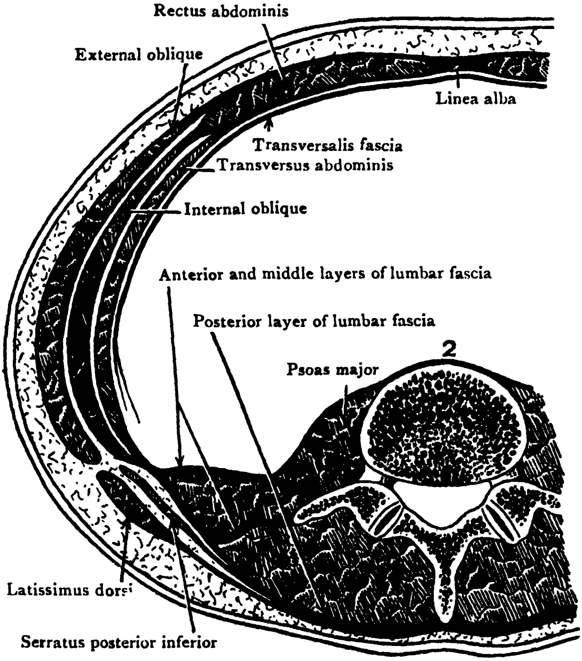


FIG. 18.—Diagram of the Lumbar Fascia.

The dissectors of the Head and Neck and of the Abdomen assist one another in displaying the three layers of fascia in the loins. The dissection is described in Volume II. ; and the connexions of the layers are given more fully there.

When the dissectors have studied the lumbar fascia, they will return to the upper part of the back.

> ***Dissection.***—**Reflect the *serratus posterior superior* and secure its nerves, which enter its deep surface. Remove the thoracic extension of the lumbar fascia, and study the *splenius*.**

Splenius.—The splenius has a continuous origin from the lower half of the ligamentum nuchæ, and from the spines of the seventh cervical and upper six thoracic vertebræ. Its fibres pass obliquely upwards and laterally, forming a thick, flat muscle which soon divides into a cervical and a cranial portion, termed respectively the splenius cervicis and the splenius capitis.

The *splenius cervicis* curves forwards and is inserted, by tendinous slips, into the transverse processes of the upper two or three cervical vertebræ behind the levator scapulæ, which overlaps it and excludes it from the floor of the posterior triangle.

The *splenius capitis* passes under cover of the upper part of the sterno-mastoid muscle, and gains insertion into the lower part of the mastoid temporal bone and into the lateral portion of the superior nuchal line. To see the insertion, divide the sterno-mastoid muscle along the superior nuchal line (but do not detach it from the temporal bone).

The splenius bends the head and neck backwards and turns them towards its own side. It is supplied by the posterior primary rami of the cervical nerves, and is pierced by their cutaneous branches.

> ***Dissection.***—**Detach the splenius from its origin and throw it towards its insertion—preserving the cutaneous branches of the cervical nerves.**

The structures exposed by the reflexion of the splenius and the removal of underlying fat are :—(1) A portion of the *occipital artery* and some of its branches. (2) A great part of a massive muscle—*semispinalis capitis*—alongside the median plane. (3) Part of a long, slender muscle called the *longissimus capitis*, deeply placed behind the transverse processes. (4) The lateral part of two small muscles, between the semispinalis capitis and the first cervical transverse process ; they are two of the suboccipital muscles—namely, the *obliquus capitis superior* and *inferior*. (5) *Branches of the posterior primary rami*, piercing the semispinalis.

Identify them all.

The muscles exposed are classed among the deeper layers of the muscles of the back.

THIRD AND FOURTH LAYERS OF MUSCLES OF THE BACK. —Those in the **third** layer are the subdivisions of two muscles —namely, *sacro-spinalis* and *semispinalis*.

Sacro-Spinalis.—This muscle begins on the sacrum and passes up into the loin, where it thickens to form the mass of muscle alongside the lumbar spines; it then divides into three columns which extend upwards over the back of the chest, where they are inserted into ribs and vertebræ but maintain their existence by means of fresh slips that arise from these bones and are continued up into the neck, and one of them (the *longissimus capitis*) reaches the skull.

Semispinalis.—The semispinalis is situated more deeply. It is made up of a succession of slips that arise from the thoracic transverse processes, join together and pass obliquely upwards. It is divided into three parts according to the insertion—semispinalis *thoracis* into upper thoracic spines, s. *cervicis* into cervical spines and s. *capitis* into the skull.

The members of the **fourth** layer are deeply-situated muscles connected with the back of the sacrum, with transverse processes, with laminæ and with spines. They are named *multifidus*, *rotatores*, *interspinales*, *intertransversarii*, and the *suboccipital muscles*.

The muscles of both the third and the fourth layers are all supplied by the posterior primary rami of the spinal nerves, and their actions as prime movers, synergists, antagonists and fixation muscles are of importance in all movements of the body.

The students will find the names of the subdivisions of the sacro-spinalis and a detailed description of the attachments and actions of all these muscles in the large Text-books of Anatomy, and will find a method of dissecting them described in former editions of this Manual; but, in an ordinary dissection, they will confine themselves to the study of certain of those that are found in the back of the neck.

Levatores Costarum.—Besides the muscles in the third and fourth layers of the back, there is a series of twelve small muscles found in the deepest part of the back that belong to the Thorax and are supplied by the anterior primary rami of thoracic nerves. They are the *levatores costarum*, which radiate from the tips of the transverse processes of the seventh cervical and upper eleven thoracic vertebræ to the posterior part of the shafts of the twelve ribs. Each levator costæ is supplied by the nearest intercostal nerve.

Identify again the structures exposed by the reflexion of the splenius (p. 67). Clean them and study them.

> ***Dissection.***—**Clean the *semispinalis* and *longissimus capitis*. While cleaning the semispinalis capitis, take care of the cutaneous branches of the posterior primary rami that pierce it ; they all emerge from the muscle close to the median plane. The uppermost of these—the *greater occipital*—runs little risk on account of its great thickness, but the others are liable to be overlooked.**
>
> **Then, clean the *occipital artery*—pushing the longissimus capitis aside or reflecting it in order to trace the artery under cover of the mastoid process. Clean also the branches of the artery.**
>
> **Finally, clean the parts of the suboccipital muscles that are exposed.**

Longissimus Capitis.—The longissimus capitis lies under cover of the splenius immediately behind the cervical transverse processes (Fig. 20). It is a long, slender muscle—about half the thickness of a finger. Because of that, it is easily recognised in an operation on the back of the neck and is a guide to the depth which the surgeon has reached. It arises chiefly from the transverse processes of the upper four thoracic vertebræ, and passes upwards to be inserted into the back of the mastoid temporal bone under cover of the splenius and sterno-mastoid.

Occipital Artery.—This artery arises from the external carotid in the front of the neck. Its first part runs upwards and backwards along the lower border of the posterior belly of the digastric muscle to reach the skull under cover of the mastoid process. The second part emerges from under cover of the mastoid process and runs along the superior nuchal line to the point where it pierces the trapezius and becomes the third part, which ramifies on the back of the head.

The **second part of the occipital artery** lies first on the obliquus capitis superior and then on the semispinalis capitis, at their insertions into the occipital bone. It is at first deeply placed under cover of the mastoid process and the muscles attached to it—namely, sterno-mastoid, splenius, longissimus capitis and the posterior belly of the digastric. (Occasionally it is superficial to the longissimus as in Fig. 20.) Having emerged from under cover of them, it crosses the apex of the posterior triangle to disappear under the trapezius, which it pierces about an inch lateral to the occipital protuberance.

Branches.—The branches of the second part of the occipital artery are a *mastoid* branch and *muscular* branches, including the descending branch.

The *mastoid branch* is a small twig that runs upwards and soon enters the mastoid foramen to supply the bone and the dura mater.

The muscular branches are mostly small twigs to neighbouring muscles; but the *descending branch* is a fairly large artery which runs downwards among the muscles of the back of the neck.

Semispinalis Capitis.—This long, thick muscle underlies the trapezius and the splenius ; but, in thin people, it produces the rounded muscular ridge seen at the side of the median furrow of the back of the neck. It has the same origin as the longissimus capitis, and is inserted into the medial half of the area between the superior and inferior nuchal lines. It is separated from its fellow muscle of the opposite side by a membranous partition called the ligamentum nuchæ.

It bends the head backwards ; and is supplied by the posterior primary rami of the upper cervical nerves.

***Dissection.*—Detach the semispinalis capitis from the occiput and throw it laterally, taking care of the nerves that pierce it and the structures that underlie it. In the dense fascia under the muscle, find and clean the *deep cervical artery*. Look for a twig from the first posterior primary ramus that enters the upper part of the muscle and for a larger branch to the muscle from the greater occipital nerve.**

As soon as the twig from the first nerve is secured, cut out a small piece of the muscle to which the nerve goes, and leave it attached to the nerve to serve as a guide to the other branches of the first cervical nerve when the suboccipital triangle is dissected.

The *semispinalis cervicis* is under cover of the lower part of the semispinalis capitis, and is now partly exposed. Define its attachments and clean its surface—preserving the posterior primary rami that lie on it.

The suboccipital triangle is now exposed, for it is under cover of the splenius and the semispinalis capitis ; and it will be dissected after the semispinalis cervicis is examined ; but the first structure to be examined now is the *ligamentum* *nuchæ*, which also has been exposed by the reflexion of the semispinalis capitis.

Ligamentum Nuchæ (Fig. 19).—This ligament is a strong, fibrous median partition between the muscles of the two sides of the back of the neck. It represents a powerful elastic structure in quadrupeds which helps to sustain the weight of the dependent head. In Man, however, there is not much elastic tissue in it, and it appears to be a continuation upwards of the supraspinous ligament from the spine of the seventh cervical vertebra to the external occipital protuberance. In shape, it is nearly triangular. By its base it is attached to the external occipital crest; by its anterior border it is fixed by a series of slips to the posterior tubercle of the atlas and to the spines of the other cervical vertebræ. Its apex is attached to the spine of the seventh cervical vertebra; and its posterior border gives origin to muscles.

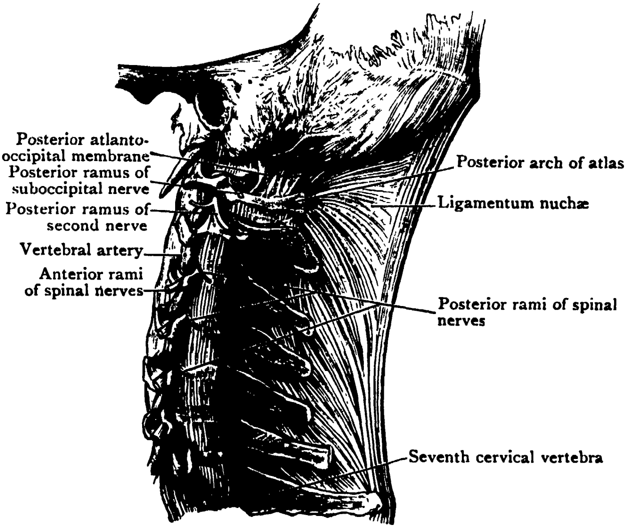

Posterior atlanto-occipital membrane
Posterior ramus of suboccipital nerve
Posterior ramus of second nerve
Vertebral artery
Anterior rami of spinal nerves
Posterior arch of atlas
Ligamentum nuchæ
Posterior rami of spinal nerves
Seventh cervical vertebra

FIG. 19.—Dissection of Ligamentum Nuchæ and of the Vertebral Artery in the Neck.

Deep Cervical Artery.—This vessel springs from the costo-cervical branch of the subclavian, and reaches the back of the neck by passing between the seventh cervical transverse process and the neck of the first rib. It ascends between the semispinalis capitis and cervicis muscles and anastomoses with the descending branch of the occipital artery.

The *deep cervical vein* is a large vessel that begins in the suboccipital plexus, descends under cover of the semispinalis capitis, turns forwards below the seventh cervical transverse process, and ends in the vertebral

Semispinalis Cervicis.—This is a bulky muscle that is hidden under cover of the semispinalis capitis, and has almost the same origin as that muscle. Its fibres pass obliquely upwards to be inserted into the spines of cervical vertebræ from the fifth to the second—chiefly into the second, and it is on account of the insertion of this large muscle into it that the spine of the axis vertebra is so thick and strong.

Suboccipital Triangle (Fig 20).—This small, triangular area is *bounded* by three muscles—(1) the rectus capitis posterior major forms its upper and medial boundary; (2) the obliquus inferior limits it below; and (3) the obliquus superior bounds it above and to the lateral side. It is *roofed* over by muscles which have been reflected—splenius capitis, semispinalis capitis and longissimus capitis—and, under cover of the semispinalis capitis, it is crossed by the greater occipital nerve. *Its floor* consists of two structures—viz., the posterior arch of the atlas and the posterior atlanto-occipital membrane. Its *contents* are a portion of the vertebral artery, the posterior ramus of the first cervical nerve and the suboccipital plexus of veins—all embedded in tough fibrous tissue mingled with fat.

Dissection.—**The dissection of the suboccipital space is difficult, because of the denseness and toughness of the fibrous tissue in it.**

The first structures to secure are the *posterior primary ramus of the first cervical nerve* and its branches. The branch to the semispinalis capitis was retained with a small piece of the muscle attached to it (p. 70); trace it until it joins the posterior ramus; then, follow the other branches from the posterior ramus to their terminations (see Fig. 20). Next, clean the muscles that bound the space, and remove the remains of the fascia from the space, and display the *posterior arch of the atlas*, the third portion of the *vertebral artery*, and the *posterior atlanto-occipital membrane.*

Posterior Primary Ramus of First Cervical Nerve.—This ramus enters the suboccipital triangle by passing backwards between the posterior arch of the atlas and the vertebral artery; and, near the roof, it breaks up into:—(1) five *muscular branches* which supply the two posterior recti, the two oblique muscles, and the semispinalis capitis;

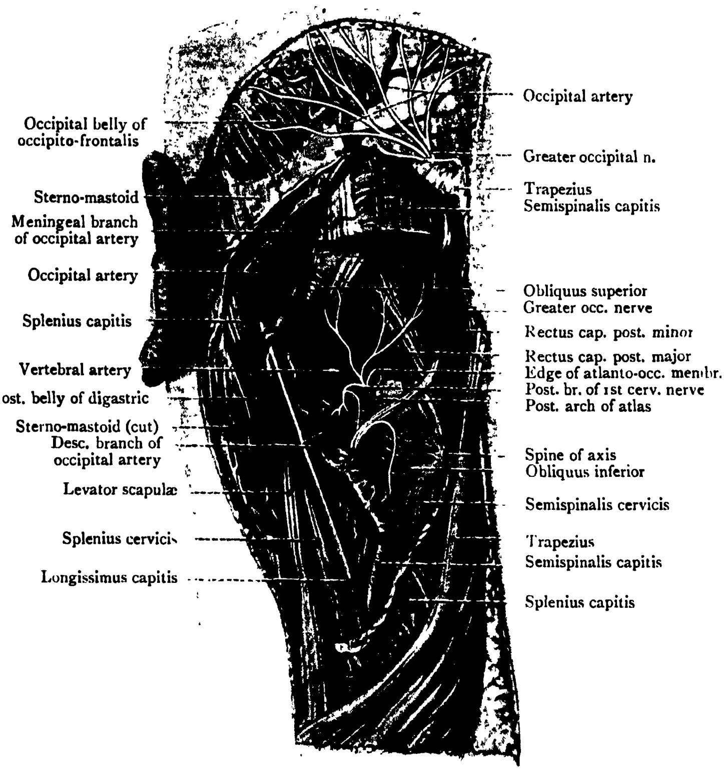


FIG. 20.—Dissection of Suboccipital Region. Note that in this specimen the occipital artery was superficial to the longissimus capitis muscle.

(2) a *communicating branch* to the greater occipital nerve; and (3) sometimes a *cutaneous filament*.

The *muscular* branches diverge from one another to reach their muscles; and the branch to the rectus minor has to cross or pierce the major to reach the minor. The *communicating* branch arises from the nerve to the inferior oblique muscle. The *cutaneous* branch, when present, accompanies the occipital artery to the skin over the occiput.

Vertebral Artery.—Only the third portion of the vertebral artery lies in the suboccipital triangle. It emerges from the foramen in the transverse process of the atlas, and runs backwards and medially in the groove on the posterior arch of that bone. As it passes medially, it lies immediately behind the lateral mass of the atlas and above the first cervical nerve. It leaves the space by passing in front of a fibrous band that stretches from the posterior arch of the atlas to its lateral mass ; this band is the free and thickened lateral part of the lower border of the posterior atlanto-occipital membrane, and the dissectors should not be surprised if they find that it is a bar of bone instead of a fibrous band. Having left the triangle, the artery pierces the dura mater and enters the vertebral canal (Fig. 44).

Suboccipital Plexus of Veins.—This network of veins lies on the muscles that bound the triangle and in the dense fascia that covers the vertebral artery. It is formed by the union of—(1) small *muscular veins* ; (2) the *occipital veins* ; (3) veins from the plexuses within the vertebral canal; and (4) the *emissary vein* which passes through the posterior condylar foramen and connects the plexus with the sigmoid sinus inside the skull. The plexus of veins that surrounds the second part of the vertebral artery begins in the suboccipital plexus, as does also the deep cervical vein.

Suboccipital Muscles (Fig. 20).—The attachments and actions of these four small muscles should now be studied.

The *rectus capitis posterior major* springs by a pointed origin from the spine of the axis, and, expanding as it passes upwards and laterally, it is inserted into the lateral half of the area below the inferior nuchal line. It draws the head backwards and rotates it to the same side.

The *rectus capitis posterior minor* is a small fan-shaped muscle, placed to the medial side of the rectus major and overlapped by it. It arises from the tubercle on the posterior arch of the atlas, and is inserted into the medial part of the area below the inferior nuchal line. It draws the head backwards.

The *obliquus capitis inferior* extends from the spine of the axis to the transverse process of the atlas. The greater occipital nerve hooks round its lower border. It rotates the atlas and the head to the same side.

The *obliquus capitis superior* springs from the transverse process of the atlas, and passes backwards and slightly upwards to be inserted into the lateral half of the area between the nuchal lines. Acting with its fellow of the opposite side, it tilts the head backwards. Acting alone, it turns the head slightly to the opposite side.

Greater Occipital Nerve.—This is the thickest cutaneous nerve in the body. It is the medial branch of the posterior primary ramus of the second cervical nerve, and makes its appearance at the middle of the lower border of the obliquus capitis inferior. It then curves upwards and medially across the suboccipital triangle (Fig. 20), pierces the semispinalis capitis, continues upwards on the surface of that muscle, and pierces the trapezius and the deep fascia at their attachment to the superior nuchal line about an inch lateral to the occipital protuberance. It then ramifies in the superficial fascia of the back of the head, where it has been examined already (p. 18). Though destined almost entirely for the skin of the head, it gives branches to the semispinalis capitis as it pierces that muscle.

Third Occipital Nerve.—This is the slender cutaneous nerve that springs from the medial branch of the posterior primary ramus of the third cervical nerve. It pierces the semispinalis capitis and trapezius and the deep fascia to supply the skin of the nape of the neck and the skin over the external occipital protuberance.

Posterior Primary Rami of Spinal Nerves.—The nerves of the back must now be examined. They are the posterior primary rami of the spinal nerves. With *four* exceptions (viz., the first cervical, the fourth and fifth sacral, and the coccygeal), each posterior ramus divides into a *lateral* and a *medial branch.*

Both of these branches supply muscles, and one or other of them gives off a cutaneous branch. These cutaneous branches have been seen already, and have been partly destroyed by the dissectors of the Neck and the Limbs when the superficial muscles were reflected; but look for the proximal parts of the nerves among the muscles that remain. Some of the cervical members have been found already on the surface of the semispinalis cervicis; the cutaneous branches in the upper half of the back of the chest appear about a thumb's breadth from the median plane, and, in the lower half, about a hand's breadth from that plane. The dissectors of the Lower Limb have already found the cutaneous branches of the lumbar posterior rami at the iliac crest, and of the sacral rami below the posterior superior iliac spine.

Cervical Region.—The posterior primary ramus of the *suboccipital* or *first spinal nerve* has been dissected already; it fails to divide into a medial and a lateral branch, and it seldom gives off a cutaneous branch.

The posterior primary ramus of the *second cervical nerve* is very large. It appears between the vertebral arches of the first and the second cervical vertebræ; and its medial branch is the **greater occipital** nerve (p. 75).

The posterior primary rami of the remaining *six cervical nerves* arise in the intervertebral foramina, and turn backwards to appear in the intervals between the transverse processes. Their *lateral branches* are of small size, and are entirely devoted to the supply of adjacent muscles.

The *medial branches* of the *third, fourth, fifth* and *sixth nerves* run medially between the semispinalis cervicis and the semispinalis capitis, communicating with one another and with the second to form a small looped plexus. When close to the median plane they turn backwards, pierce the muscles, and become cutaneous—the cutaneous branch of the third being called the third occipital nerve (p. 75). In their course to the surface they give numerous twigs to the neighbouring muscles.

The medial branches of the *seventh* and *eighth* run deep to the semispinalis cervicis and are spent in muscles.

Thoracic Region.—The posterior primary rami of the thoracic nerves make their appearance between the transverse processes. The *lateral branches* proceed laterally, under cover of the middle column of the sacro-spinalis and appear between that column and the lateral column (p. 68). The *upper six* or *seven* are exhausted in the supply of these two columns; the *lower five* or *six*, however, are considerably larger, and contain both motor and sensory fibres. After giving up their motor fibres to the muscles, they become superficial by piercing the serratus posterior inferior and the latissimus dorsi, in line with the angles of the ribs. Their cutaneous distribution has already been examined by the dissectors of the Upper Limb.

The *medial branches* also are distributed differently in the upper and lower portions of the thoracic region. The *lower five* or *six* are very small, and end in the multifidus muscle. The *upper six* or *seven* pass medially across the multifidus, and, after supplying muscles, they become cutaneous. In passing towards the surface they pierce the splenius, rhomboid and trapezius muscles, and thus gain the superficial fascia, where they have been dissected already.

Lumbar Region.—The *medial branches* of the posterior rami of the five lumbar nerves are small, and end in the multifidus.

The *lateral branches* sink into the substance of the sacro-spinalis, and are concerned in the supply of that muscle, and also of the lumbar intertransverse muscles. The lateral branches of the **upper three lumbar nerves** are of large size; they become cutaneous by piercing the superficial lamella of the lumbar fascia, and they have already been traced by the dissectors of the Lower Limb to the skin of the gluteal region. The lateral branch of the fifth communicates with the corresponding branch of the first sacral nerve.

Sacral Region.—The sacral posterior primary rami are very small.

The upper four emerge through the posterior sacral foramina; to expose them, remove the muscles that cover these apertures. The *medial branches* of the **upper three** are lost in the multifidus. Their *lateral branches* are larger; they give twigs to the multifidus and sacro-spinalis, and then unite to form loops on the back of the sacrum; from these loops, cutaneous branches pass through the gluteus maximus to the skin of the medial part of the gluteal region.

The **fourth** does not divide into lateral and medial branches; it runs downwards to join the fifth.

Coccygeal Region.—The posterior primary ramus of the **fifth sacral** nerve and that of the **coccygeal nerve** descend through the lower end of the sacral canal. They unite with each other and with the fourth, and supply the ligaments and the skin on the back of the coccyx and lowest part of the sacrum.

Blood-Vessels of the Back.—In the **cervical region**, the *deep cervical artery*, the *descending branch of the occipital artery*, and the *third part of the vertebral artery* have been seen already. In addition, however, minute muscular twigs from the second and third parts of the vertebral artery may be discovered, in a well-injected body, passing backwards between the transverse processes, and also in the suboccipital triangle.

In the **thoracic region**, the *posterior branches of the intercostal arteries* pass backwards between the bodies of the vertebræ and the costo-transverse ligaments, and are distributed, with the posterior primary rami, to the muscles and skin of the back.

In the **lumbar region**, similar branches are derived from the lumbar arteries. They are distributed in the same manner.

In both thoracic and lumbar regions, before reaching the back, the vessels send small *spinal branches* into the vertebral canal through the intervertebral foramina. These will be traced at a later period.

The *veins* accompanying the posterior branches of the lumbar and intercostal arteries pour their blood into the lumbar and intercostal veins. They are of large size, being joined by tributaries from the posterior vertebral venous plexus, and also by others from within the vertebral canal.

Posterior Vertebral Venous Plexus.—A plexus of veins is situated on the superficial aspect of the vertebral arches subjacent to the multifidus muscle. Blood passes to it from the skin and muscles of the back, and is conveyed by it, in the thoracic and lumbar regions, into the posterior tributaries of the intercostal and lumbar veins. In the neck it is especially well marked; and there the blood is emptied from it into the vertebral veins. In an ordinary dissection, the plexus is not very noticeable, but it may be a source of serious trouble during operations on the vertebræ.

On the fourth day after the body was placed face downwards, the dissectors should have completed the study of the soft parts of the back; on the fifth day they will open the vertebral canal and study its contents.

***Dissection.*—Remove the muscles completely from the spines and laminæ and from the dorsum of the sacrum, and clean the spines and laminæ and their ligaments. At the same time, retain the posterior primary rami of the nerves, in order that their continuity with the nerve-trunks may be established afterwards. Then, remove the posterior wall of the vertebral canal *in one piece* by sawing through the laminæ on each side**

and dividing the ligamenta flava, from the third cervical vertebra down to the lower opening of the sacral canal.

In making this dissection, attend to the following points: (1) Make the cut through the laminæ close to the medial sides of the articular processes; (2) slant the saw through the laminæ slightly medialwards; (3) as the cervical laminæ are cut through, the head and neck should hang over the end of the table, and be flexed as much as possible, whilst the saw is worked from below upwards; (4) before using the saw in the lumbar region—where, indeed, most difficulty will be met—place a high block under the abdomen and remove the blocks supporting the chest and pelvis; in this region, it will probably be necessary to have recourse to the hammer and chisel.

Wrap the laminæ and spines and their ligaments in cloth soaked with preservative and in oil-cloth, and lay them aside until the joints of the neck are examined (p. 267). But while the specimen is fresh, test the high elasticity of the ligamenta flava by stretching them.

Now, examine the contents of the vertebral canal.

Extra-dural Space.—This name is given to the interval that separates the walls of the vertebral canal from the spinal dura mater (p. 79). It is filled with loose areolar tissue, semiliquid fat and networks of veins that correspond morphologically to the venous sinuses in the cranium. It contains also the arteries that supply the structures in the canal and the bones and ligaments around it. The fat is especially *plentiful in the sacral region, where it resembles the marrow in the medullary cavity of a long bone.*

Spinal Arteries.—These minute arteries come from the vertebral, ascending and deep cervical, posterior branches of intercostal and lumbar arteries and from the lateral sacral arteries. They enter the vertebral canal through the intervertebral foramina; and they supply the spinal cord and its meninges, the nerve roots, the bones, the periosteum, and the ligaments.

Internal Vertebral Venous Plexus.—This plexus extends along the whole length of the vertebral canal, and is divided into four subordinate longitudinal plexuses—two anterior and two posterior.

The *posterior plexuses* lie on the deep surface of the laminæ and ligamenta flava; the *anterior plexuses* lie on the back of the vertebral bodies along the edges of the posterior longitudinal ligament; and they are united by many cross branches. They receive veins from the bones and ligaments around them—the veins that emerge through the backs of the vertebral bodies being specially large. They communicate:—*posteriorly* with the posterior vertebral plexus (p. 77); *superiorly* with the occipital sinus and basilar plexus of sinuses inside the skull, and with the suboccipital plexus; and *on each side* with the posterior tributaries of the intercostal and lumbar veins.

Meninges of Spinal Cord (Fig. 21).—The spinal cord, like the brain, is enveloped in three membranes or *meninges*.

The most external investment is a strong fibrous membrane called the *dura mater*; the second is a thin, non-vascular tunic of delicate fibrous tissue termed the *arachnoid mater*; and the third and most internal is a thick, vascular fibrous coat called the *pia mater*. The three membranes are directly continuous with the corresponding investments of the brain.

> ***Dissection.*****—Clean the outer surface of the dura mater by removing the loose areolar tissue, soft fat, and veins from the vertebral canal. Define also the numerous lateral prolongations which the dura mater gives to the spinal nerves.**

Spinal Dura Mater (Fig. 21).—In the vertebral canal the dura mater is in the form of an exceedingly dense and tough fibrous tube which extends from the foramen magnum to the level of the second piece of the sacrum. It is separated from the walls of the vertebral canal by the contents of the extra-dural space. The membranous tube is very capacious in comparison with its solid contents; and even before it is laid open the dissectors can readily satisfy themselves that it forms a very loose sheath around the spinal cord and around the collection of long nerve-roots which form the *cauda equina* below the spinal cord. Its calibre, however, is by no means uniform: in the cervical and lumbar regions it is considerably wider than in the thoracic region, whilst in the sacral canal it rapidly contracts and finally ends blindly at the level of the second sacral vertebra.

The tube of dura mater does not lie free within the vertebral canal, but its attachments do not in any way interfere with the free movement of the vertebral column. *Above*, the dura mater is firmly adherent to the margin of the foramen magnum, and to the bodies of the second and third cervical vertebræ. *Below*, it is anchored to the coccyx by the *filum terminale*, which is a fibrous thread that descends from the pia mater at the end of the spinal cord, pierces the lower end of the dural tube, and runs onwards to be attached to the back of the coccyx. *On each side*, as the spinal nerve-roots pierce the dura mater, they carry off tubular sheaths of the membrane, which are attached to the margins of the intervertebral foramina. *Anteriorly*, loose fibrous strands — more numerous above and below than in the thoracic region— connect the dura mater to the posterior longitudinal ligament of the vertebral column. No connexion of any kind exists between the dura mater and the vertebral arches or the ligamenta flava.

***Dissection.*—Open the tube of dura mater by a median incision made with scissors—taking care not to injure the arachnoid mater.**

Subdural Space.—The deep surface of the dura is

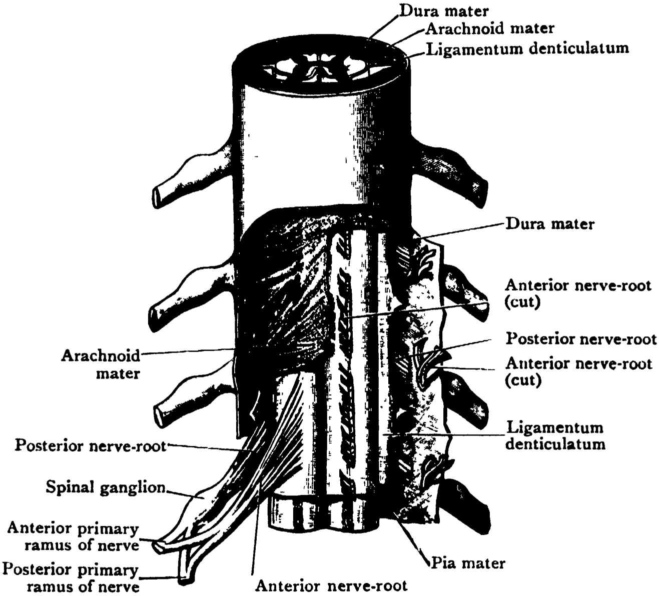


FIG. 21.—Membranes of Spinal Cord, and Mode of Origin of Spinal Nerves.

smooth, moist and polished, and the capillary interval between it and the arachnoid mater is named the ***subdural space*** (Fig. 21). The dissector will notice, on each side, the series of apertures of exit for the roots of the spinal nerves. There are two opposite each intervertebral foramen. The subdural space is prolonged for a short distance on each of the two nerve-roots, and has a free communication with the lymph-channels in the nerves.

Viewed from the inside of the tube of dura mater, each of the two roots of a spinal nerve is seen to carry with it a distinct sheath. When examined on the outside of the tube, they appear to be enveloped in one sheath,

because the two sheaths are closely held together, on the outside, by intervening areolar tissue—which can be removed with a little careful dissection. When that is done, the two tubular sheaths will be seen to remain distinct as far as the ganglion on the posterior root of the nerve. At that point they blend with each other.

Spinal Arachnoid Mater (Fig. 21).—The arachnoid mater, like the dura mater, forms a loose, wide investment for the spinal cord; but, unlike the dura, it is remarkable for its great delicacy and transparency. Above, it becomes continuous, through the foramen magnum, with the arachnoid mater of the brain. On each side, it is prolonged over the nerve-roots as tubular sheaths. Below, it ends blindly at the level of the second sacral vertebra, where it is pierced by the filum terminale. It is most capacious and most easily demonstrated in its lower part, where it envelops the extremity of the cord and the cauda equina.

> ***Dissection.***—**Inflate the arachnoid with a blowpipe; and then make an incision in its lower part and explore it with the handle of the knife.**

Subarachnoid Space (Fig. 21).—The subarachnoid space is the wide interval between the arachnoid and pia mater. At the foramen magnum, it is continuous with the cranial subarachnoid space; and, like that space, it is filled with a clear liquid called the *cerebro-spinal fluid.* Three incomplete septa partially divide the spinal subarachnoid space into compartments. One of the septa is a median partition, called the *subarachnoid septum*, which connects the arachnoid with the pia mater on the back of the spinal cord; it is almost complete in the thoracic region and lower part of the cervical region, but above that level it is represented merely by isolated strands. The other two septa are the *ligamenta denticulata.* They spread laterally, one from each side of the spinal cord, and will be studied with the pia mater.

> ***Dissection.***—**Take away the arachnoid mater from a portion of the spinal cord, and proceed to the study of the pia mater.**

Spinal Pia Mater.—The pia mater of the spinal cord—thicker than the pia mater of the brain—is a firm vascular membrane which adheres closely to the spinal cord, and, at the lower end of the cord, it is continued into the filum terminale. The posterior median septum of the cord (p. 89) is firmly attached to its deep surface. It is folded into the anterior median fissure of the cord; the two layers of the fold are adherent to each other, and, at the surface, are thickened to form a median, longitudinal glistening band called the *linea splendens.* Of course, that can be seen only after the spinal cord has been removed from the vertebral canal. The blood-vessels of the spinal cord ramify in the pia mater before they enter the substance of the cord; and the various spinal nerves receive from it closely-fitting sheaths which blend with their coverings of fibrous tissue.

Ligamenta Denticulata (Fig. 21).—There is a pair of denticulate ligaments. Each is a thin ridge that stands out from the pia mater on the side of the spinal cord midway between the anterior and posterior nerve-roots. It extends from the level of the foramen magnum to the level of the first lumbar vertebra. A number of pointed processes project from its free edge, push the arachnoid mater before them, and are attached to the dura mater; and, by this means, the denticulate ligaments maintain the spinal cord in the middle of the tube of dura mater. There are twenty-one of these "teeth." Each is opposite the interval between two nerves. The first is at the level of the foramen magnum; the last is below the last thoracic nerve.

Filum Terminale.—This delicate, thread-like filament is about six inches long. It lies amidst the roots of the lumbar and sacral nerves, but it can readily be distinguished from them (1) by its silvery, glistening appearance, and (2) by its continuity with the end of the spinal cord (Fig. 22).

It is composed chiefly of pia mater, although the central canal of the spinal cord is prolonged down in its interior for nearly half its length, and nervous elements can be traced in its substance for a like distance. The *linea splendens* and the *ligamenta denticulata* are continued into it. At the level of the second sacral vertebra it pierces the end of the tubes of arachnoid and dura mater, and receives an investment from them; finally, it escapes through the lower end of the sacral canal, and terminates by blending with the periosteum on the back of the coccyx or the last piece of the sacrum.

Spinal Cord.—The spinal cord itself may now be studied *in situ.* It is almost cylindrical in form but is slightly flattened in front and behind. It begins at the foramen magnum, where it is continuous with the medulla oblongata of the brain; and it ends at the lower border of the body of the first lumbar vertebra or the upper border of the second. Its lowest part rapidly tapers to a point, and is termed the *conus medullaris.*

The average length of the spinal cord is about 18 *inches*—in men 45 cm., in women 43 cm.

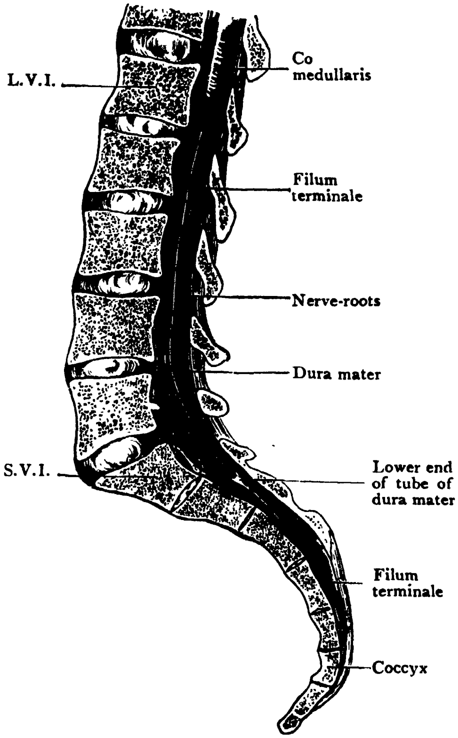


FIG. 22.—Sagittal Section through lower part of Vertebral Canal.

In the greater part of the thoracic region of the vertebral column, the cord presents a uniform girth, but in the cervical and lower thoracic regions it shows marked swellings. The *cervical enlargement*, which is connected with the nerves of the upper limbs, is the more evident of the two. It begins at the upper end of the spinal cord, attains its greatest breadth (13 or 14 mm.) opposite the fifth or sixth cervical vertebra, and subsides opposite the second thoracic vertebra. The *lumbar enlargement* is connected with the nerves of the lower limbs. It begins at the level of the tenth thoracic vertebra, attains its maximum transverse diameter (11 to 13 mm.) opposite the last thoracic vertebra, and then rapidly tapers into the conus medullaris.

Spinal Nerves.—Thirty-one pairs of spinal nerves are attached to the spinal cord. They are classified into five groups according to the vertebræ with which they are associated. The thoracic, lumbar, and sacral nerves correspond in number with the vertebræ in those regions—twelve thoracic, five lumbar, and five sacral nerves—each of which issues from the vertebral canal below the vertebra with which it corresponds numerically. In the cervical region, however, there are eight nerves. Each of the upper seven emerges above the vertebra of corresponding number ; and the eighth emerges below the seventh cervical vertebra. There is only one pair of coccygeal nerves.

Spinal Nerve-Roots (Figs. 21 and 23).—Each spinal nerve is attached to the spinal cord by *two roots*—an *anterior* and a *posterior*. The posterior nerve-root is the larger (except in the first cervical), and is further distinguished by possessing an oval ganglion termed the *spinal ganglion*. There is, also, a physiological difference between the two roots—the posterior root is composed of afferent (sensory) fibres, the anterior root of efferent (motor) fibres. Immediately beyond the ganglion the two roots unite to form the *spinal nerve-trunk*, which contains therefore both kinds of fibres.

Each of the two nerve-roots is made up of a number of separate *rootlets* which spread out from one another as they approach their attachments, but the *mode of attachment* is different. The rootlets of the posterior root enter the spinal cord consecutively along a continuous straight line and at the bottom of a slight furrow. The rootlets of the anterior root are not so regularly placed. They emerge from the spinal cord over an area of some breadth.

The portion of the spinal cord to which any one pair of nerves is attached is called a *spinal segment*.

The *size* of the nerve-roots varies greatly. The lower lumbar and upper sacral nerve-roots are much the largest, and the lower sacral and the coccygeal roots are the smallest. In the cervical region the roots increase in size from above downwards, but more rapidly in the lower members of the group ; in the thoracic region the roots of the first nerve are large, but those which succeed it are small and of uniform size.

The nerve-roots show great differences also in *relative length*, and in the *direction* which they follow in the vertebral canal. The differences are due to the spinal cord being so much shorter than the canal in which it lies. In the upper part of the cervical region, the nerve-roots are short, and proceed laterally and almost horizontally. Below the upper cervical region, the roots become more oblique, and the lower the origin of the nerve the longer is its course in the canal. The arrangement of the lower thoracic, the lumbar, sacral, and coccygeal roots is particularly characteristic. They are very long, and descend vertically from the lower portion of the cord, forming the bundle called the *cauda equina*.

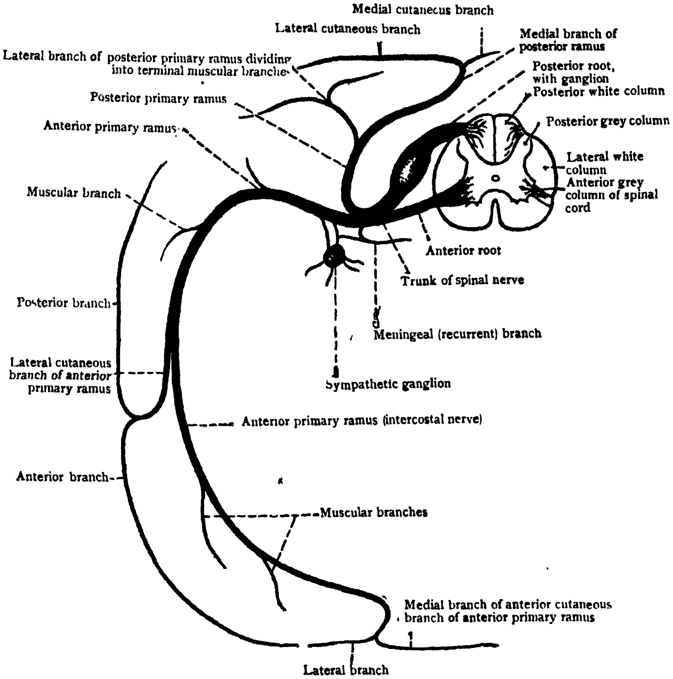

Medial cutaneous branch
Lateral cutaneous branch
Medial branch of posterior ramus
Lateral branch of posterior primary ramus dividing into terminal muscular branches
Posterior root, with ganglion
Posterior white column
Posterior primary ramus
Posterior grey column
Anterior primary ramus
Lateral white column
Anterior grey column of spinal cord
Muscular branch
Anterior root
Trunk of spinal nerve
Posterior branch
Meningeal (recurrent) branch
Lateral cutaneous branch of anterior primary ramus
Sympathetic ganglion
Anterior primary ramus (intercostal nerve)
Anterior branch
Muscular branches
Medial branch of anterior cutaneous branch of anterior primary ramus
Lateral branch

FIG. 23.—Diagram of a Typical Spinal Nerve. Note that the medial branch of the posterior primary ramus is represented as distributed to skin, whilst the lateral branch terminates at a deeper level in muscle. Both branches, however, supply muscles; and in the lower half of the body it is the lateral branch that supplies skin.

Levels.—The origins of the eight cervical nerves are between the level of the atlas and the level of the spine of the sixth cervical vertebra; the origins of the first six thoracic nerves extend from the sixth cervical to the third thoracic spine; the origins of the lower six thoracic nerves lie between the third and the ninth thoracic spines; and the origins of the lumbar and sacral nerves are between the ninth thoracic and the first lumbar spine.

Mode of Exit of Spinal Nerves from Vertebral Canal.—The lower six cervical nerves and the thoracic and lumbar nerves make their exit through the intervertebral foramina; each of the two primary rami of the upper four sacral nerves finds its way out by a sacral foramen. The upper two cervical nerves, the fifth sacral nerve, and the coccygeal nerve, follow a different course. The first cervical emerges by passing over the posterior arch of the atlas, and the second cervical nerve by passing over the vertebral arch of the axis. The fifth sacral and the coccygeal nerve leave the sacral canal through its lower end (Fig. 24).

***Dissection.*—Follow the nerve-roots of one or two spinal nerves in each region into the corresponding intervertebral foramina. Do so by snipping away the articular processes with the bone-forceps. Then, study the position of the spinal ganglion, the connexions of the sheath of dura mater, the union of the two roots, and the division of the nerve-trunk into the primary rami. Try also to find the minute meningeal branch which runs inwards from the nerve-trunk.**

Meningeal Branch.—This is a fine twig formed by the union of a small filament from the spinal nerve-trunk with a delicate branch from the sympathetic trunk. It takes a recurrent course through the intervertebral foramen to end in the bones and periosteum and meninges of the vertebral canal.

Spinal Ganglia.—These ganglia lie in the intervertebral foramina, except those of the first two cervical nerves and the sacral and coccygeal nerves. The ganglia of the first two cervical nerves lie respectively on the posterior arch of the atlas and the vertebral arch of the axis vertebra; the ganglia of the sacral nerves are placed within the sacral canal, but outside the tube of dura mater. The ganglion on the posterior root of the coccygeal nerve is inside the tube of dura mater.

Spinal Nerve-Trunks.—The trunk of a spinal nerve is *formed by the union of the nerve-roots immediately beyond the spinal ganglion. The nerve-trunk is exceedingly short, for it divides immediately into an* ***anterior*** and a ***posterior***

primary ramus. The union of sacral and coccygeal nerve-roots and the division of their trunks take place in the sacral canal; of the lumbar, thoracic and lower six cervical nerves, in the intervertebral foramina; and of the first two cervical nerves, on the arches of the atlas and axis.

The distribution of the posterior primary rami has already been examined (p. 75).

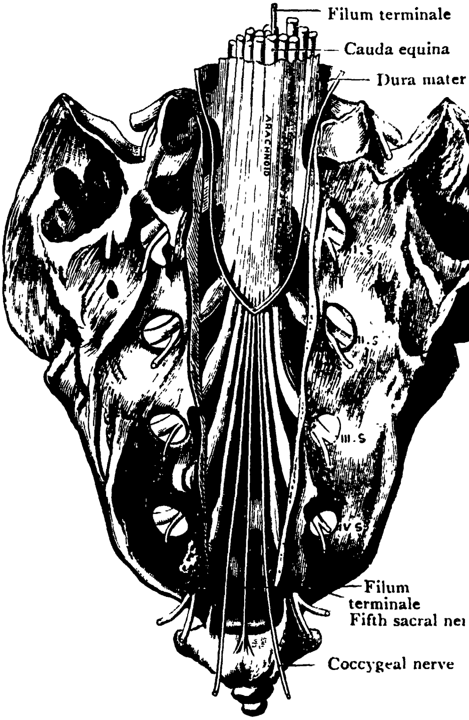


FIG. 24.—Sacral Nerve-Roots and the Membranes in relation to them (after Testut). The posterior wall of the Sacral Canal has been removed.

The cord should now be removed with all its membranes and nerve-roots, and placed in a cork-lined tray filled with water. There is no method by which the arachnoid, the pia mater, the ligamenta denticulata, and the nerve-roots can be so well studied as this.

Dissection.—**Divide the spinal nerves in the intervertebral foramina, and in such a manner that as long a piece as possible**

of each nerve remains attached to the dura mater. Wherever possible, take the ganglia with the nerves. Cut across the spinal cord and its membranes at the highest limit of the vertebral dissection. Pull upon the dura mater in order to lift the whole specimen from the vertebral canal, and then transfer it to the tray. Slit up the dura mater along the median plane anteriorly. Fix the flaps of the dura mater with pins to the cork, and display in turn the arachnoid mater and the pia mater with the ligamenta denticulata.

The membranes are described on pp. 78-82.

Arteries of Spinal Cord.—Numerous small arteries are supplied to the spinal cord; but they can be made out satisfactorily only when the red injection is particularly good. They are the *anterior* and *posterior spinal arteries*, which spring from the vertebral artery in the cranium, and are reinforced by series of branches that reach the side of the spinal cord from *spinal arteries* derived from the vertebral, ascending cervical and deep cervical arteries in the neck, and from the posterior branches of the intercostal and lumbar arteries in the trunk. By the anastomoses of the various arterial twigs, five longitudinal trunks are formed on the surface of the cord. One lies in the median plane anteriorly, under cover of the linea splendens. The others are in relation to the posterior nerve-roots—a pair in front of them and a pair behind. The branches of those trunks anastomose in the pia mater before they enter the cord.

Veins of Spinal Cord.—The veins are small, numerous and very tortuous, and form a plexus with elongated meshes. Six more or less perfect longitudinal venous trunks may be noticed in the plexus—one in the median plane in front, one in the median plane behind, a pair behind the anterior nerve-roots and a pair behind the posterior roots.

Superiorly they are continuous with the veins of the medulla oblongata; on each side, they are connected with the veins in the vertebral canal by means of small twigs which run laterally on the nerve-roots.

Naked-Eye Structure of Spinal Cord.—The spinal cord is composed of an inside core of grey matter and an external coating of white matter.

It is partially subdivided into right and left halves by an anterior median fissure, a posterior median sulcus and a posterior median septum.

The *posterior median sulcus* is a mere groove on the surface.

The *posterior median septum* is a thin sheet of a substance called neuroglia. It extends from the sulcus inwards to the centre, or even farther, in the upper part of the cord, but diminishes in depth in the lower part. The *anterior median fissure* is a narrow cleft which extends inwards for one-quarter or one-third of the thickness of the upper part of the cord, but becomes deeper as it is traced downwards, till, at the lower part, the fissure and the septum are equal in depth.

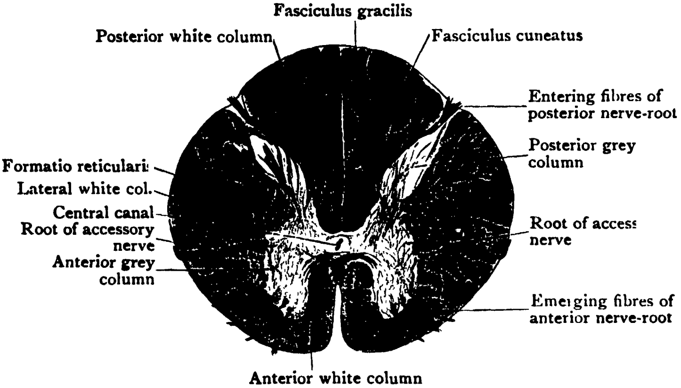


FIG. 25.—Transverse Section through upper part of Cervical Region of Spinal Cord.

The **grey matter** is in the form of a pair of long, fluted bands united across the median plane by a thin lamina of grey matter, called the *grey commissure*, which is traversed lengthwise by a narrow tunnel called the *central canal*. The canal terminates blindly in the filum terminale ; but, superiorly, it is continuous with the central canal that traverses the lower half of the medulla oblongata to open into a space called the fourth ventricle of the brain. The canal, like the ventricles of the brain and the subarachnoid space, is filled with a clear liquid called the *cerebro-spinal fluid*. The posterior septum reaches the grey commissure ; but the anterior fissure is separated from the grey commissure by a band of white matter called the *white commissure*.

The part of each fluted band that is in front of the level of the grey commissure is called the *anterior grey column*, and the part behind is the *posterior grey column*. The grey

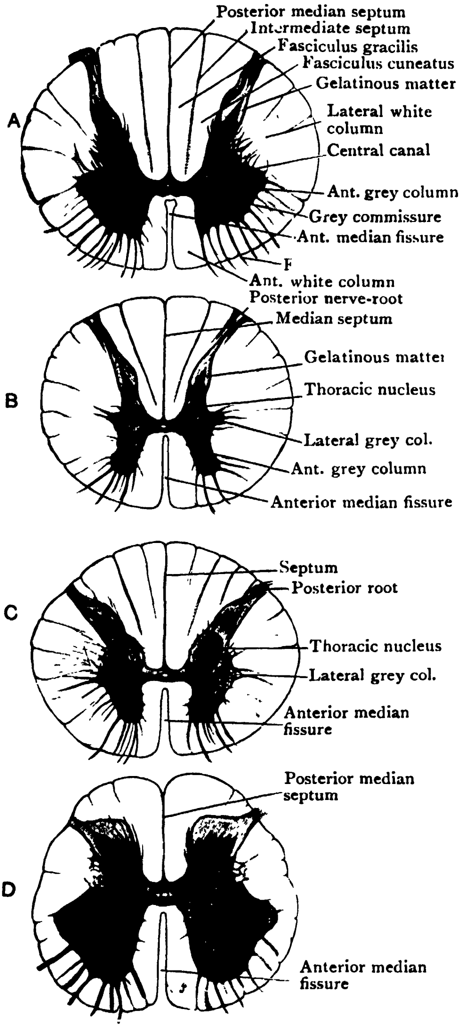


FIG. 26.—Transverse Sections through the Spinal Cord in different regions. A. Cervical Region; B. Mid-thoracic Region; C. Lower Thoracic Region; D. Lumbar Region.

columns when seen in section are called *horns* — *anterior* and *posterior*.

Dissection. **—If the spinal cord is fairly firm, or if a preserved specimen is available, make sections across it at different levels, and examine the cut surface with the naked eye and with a pocket-lens.**

Spinal Cord in Section.—The distinction between the grey and the white matter can usually be made out; and the central canal is seen (even by the naked eye) as a black speck.

The grey matter at the apex of the posterior horn has a translucent appearance, and is called the *gelatinous matter* (substantia gelatinosa).

The anterior horn is separated from the surface by a fairly thick layer of white matter; and that layer is traversed by the fibres of the anterior nerve-roots, which arise in the anterior grey column. The posterior horn almost reaches the surface at the groove through which the fibres of the posterior roots enter the cord.

The grey matter is not present in equal quantity at all levels of the cord. Therefore, it is necessary that it should be considered in different regions; and it must be understood, when the terms cervical, lumbar, etc., are applied to different portions of the cord, that those terms apply to the regions to which the corresponding nerves are attached and not to the parts that lie in relation to the vertebræ of the same name.

Wherever there is an increase in the size of the nerves attached to a particular part of the cord, there is a corresponding increase of the grey matter. It follows that the districts in which the grey matter bulks most largely are the lumbar and cervical enlargements, for the great nerves which go to form the limb-plexuses are attached to those portions of the cord. In the thoracic region, there is a reduction in the quantity of grey matter in correspondence with the smaller size of the thoracic nerves.

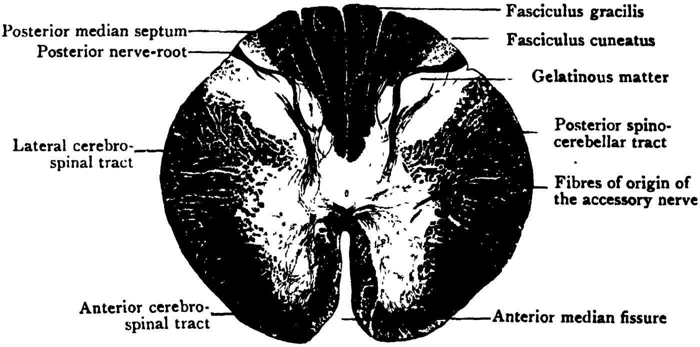

Posterior median septum
Posterior nerve-root
Lateral cerebro-spinal tract
Anterior cerebro-spinal tract
Fasciculus gracilis
Fasciculus cuneatus
Gelatinous matter
Posterior spino-cerebellar tract
Fibres of origin of the accessory nerve
Anterior median fissure

FIG. 27.—Transverse Section through upper Cervical part of the Spinal Cord of a full-time Fœtus, treated by the Weigert-Pal process.

The shape of the horns of grey matter is not the same in all regions. In the cervical region, the contrast between the grey horns is most marked; the anterior horn is very thick in comparison with the posterior horn. In the thoracic region, both horns are narrow, although the distinction between the anterior horn and the more attenuated posterior horn is still sufficiently manifest. In the lumbar region, the difference in the thickness of the two horns is not nearly so apparent, owing to a broadening out of the posterior horn. A section taken from the centre of each region can very readily be recognised by the features mentioned (Fig. 26).

In the thoracic region, more especially in the upper part, there is another character which is very distinctive. A pointed and prominent triangular projection juts out from the side of the grey matter, nearly opposite the grey commissure. It is called the *lateral grey column* or *horn* (Fig. 26, B and C). It disappears in the cervical and lumbar enlargements generally, but again becomes evident both in the upper cervical region and in the lower sacral region.

The **white matter**, in each half of the spinal cord, forms a thick coating around the fluted band of grey matter. The columns of grey matter and the fibres of the nerve-roots divide it into three *white columns—anterior, lateral* and *posterior*. The most lateral fibres of the anterior nerve-root are taken as the dividing line between the anterior and lateral white columns. The right and left anterior white columns are connected by the white commissure. The posterior column is divided into two principal bundles—the *fasciculus gracilis* medially, and the *fasciculus cuneatus* laterally—which consist of fibres derived from the posterior *nerve-roots*. In the cervical region those two fasciculi are separated by a septum of pia mater and a distinct surface groove. The other white columns are made up of a number of fasciculi or tracts of fibres which are mingled together to a considerable extent, but can be distinguished when specially prepared sections of the spinal cord are put under the microscope.

The white matter of the spinal cord increases steadily in quantity from below upwards. See 26

CRANIAL CAVITY

[illegible] 41

After the body has been five days on its face it will be replaced on its back, with the thorax and pelvis supported by blocks; and the dissectors of the Head and Neck will proceed to remove the brain and study the interior of the cranium.

Dissection.—**Support the head on a block. The epicranial aponeurosis has been incised already in the median plane. Extend the incision to the root of the nose and to the occipital protuberance, and cut through the areolar tissue and the pericranium down to the bone. With the handle of the scalpel, or with a chisel, detach the pericranium from the bone on each side and turn it downwards to the temporal lines, leaving the bone perfectly bare. On each side, detach the epicranial aponeurosis and the temporal fascia from the temporal ridge with the edge of the knife; then, carrying the edge of the knife forwards and backwards between the temporal muscle and the bone, detach the upper part of the muscle from the skull, and turn each half of the scalp down over the auricle.**

Sutural Ligaments.—The *pericranium* is the periosteum on the outer surface of the cranial bones. It is attached to the surface of the bones of the skull-cap only loosely; but it is firmly attached at the sutures, for at each suture a fibrous ribbon called the *sutural ligament* springs from the pericranium and passes edgewise between the articulating margins of the bones to fuse with the outer layer of the dura mater, which acts as the periosteum of the inner surface of the cranial bones, and is called the *endocranium* in contradistinction to the pericranium on the outside.

Dissection.—**Obtain a saw, a chisel, and a mallet, and proceed to remove the skull-cap or calvaria. Mark out the line along which the saw is to be used by encircling the skull with a piece of string, and then marking the bone with a pencil along the line of the string. Make the cut, anteriorly, fully three-quarters of an inch above the margins of the orbits, and, posteriorly, about**

half an inch or less above the external occipital protuberance. The saw should be used to divide the outer table of the skull only. When the diploë is reached, the sawdust will become red and moist, and the saw should then be abandoned. The hammer and chisel are now brought into requisition, and by short, sharp strokes with these the inner table can readily be split along the line in which the outer table is divided. Then, insinuate the hook at the end of the cross-bar of the chisel into the fissure in front, and wrench off the skull-cap.

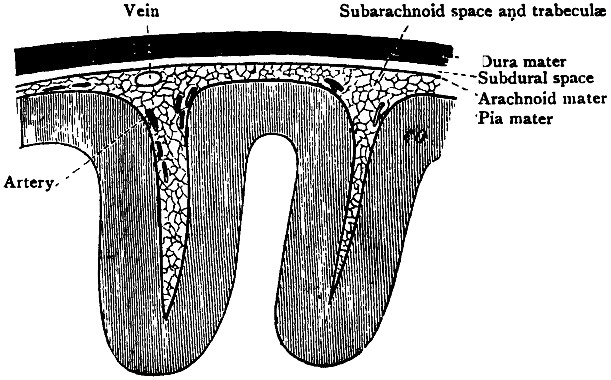


FIG. 28.—Diagrammatic Section through the Meninges of the Brain (Schwalbe).

co. Grey matter of cerebral gyri.

Dura Mater Encephali.—The brain, like the spinal cord, is clothed with three distinct membranes or *meninges*. From without inwards they are:—the dura mater; the arachnoid mater; and the pia mater.

When the skull-cap is detached, the outer surface of the upper part of the dura mater is exposed. It is dotted over with bleeding points, and is rough, owing to a multitude of fine fibrous and vascular processes by which it was connected with the bones. The bleeding points are most numerous along the median line, or, in other words, along the line of a venous channel called the superior sagittal sinus (Fig. 29); and if the handle of the knife is run from before backwards to make pressure along that line a considerable quantity of blood will ooze out, showing that a number of small veins from the cranial bones have been ruptured. The degree of adhesion between the dura mater and the cranial bones varies in different bodies and in different localities. In all cases, it is, like the pericranium, strongly adherent along the lines of the sutures, for it is fused with the sutural ligaments; and, further, it is much more firmly attached to the base than to the vault of the cranium. In the child—indeed, as long as the bones of the cranium are growing—it is more adherent than in the adult; and it is more firmly bound to the bone again in old age.

Clean the outer surface of the dura mater with a sponge. The arteries then seen are the main divisions of the *middle meningeal artery*. They ascend, in the substance of the outer layer of the dura mater, towards the vertex, and send off numerous branches in a widely arborescent manner (Fig. 31).

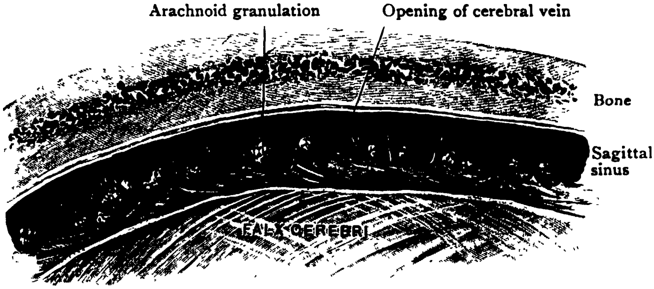


FIG. 29.—Median Section through the Frontal Bone and corresponding part of the Superior Sagittal Blood-Sinus. The arachnoid granulations are seen protruding into the sinus. (Enlarged)

These arteries are thicker than that layer, and stand out, therefore, in bold relief from the membrane, and, together with the veins which accompany them and lie external to them, they produce deep grooves on the inner surface of the skull-cap.

The meningeal arteries supply not only the membrane, as their name suggests, but also the inner table and the diploë of the cranial bones—the outer table being supplied by vessels on the exterior.

Arachnoid Granulations.—The arachnoid granulations are normally present in the adult; they increase in number and size with age, and are therefore best marked in cadavera of old people. They are small granular bodies, ranged along the sides of the superior sagittal sinus—some of them seen on the surface of the dura mater, while more of them bulge into the sinus (Figs. 29, 30). Usually, they are most evident towards the posterior part of the parietal region. At first sight they appear to be protrusions from the dura mater, but that is not the case. They spring from the arachnoid mater and the subarachnoid tissue, and are normal enlargements of microscopic processes of the arachnoid mater, called *arachnoid villi*, which are present in infants. They are most plentiful along the superior sagittal sinus, but are not confined to it: they have been found in relation to most of the other sinuses—especially at the entrance of veins (Le Gros Clark)—and even in the middle meningeal veins.

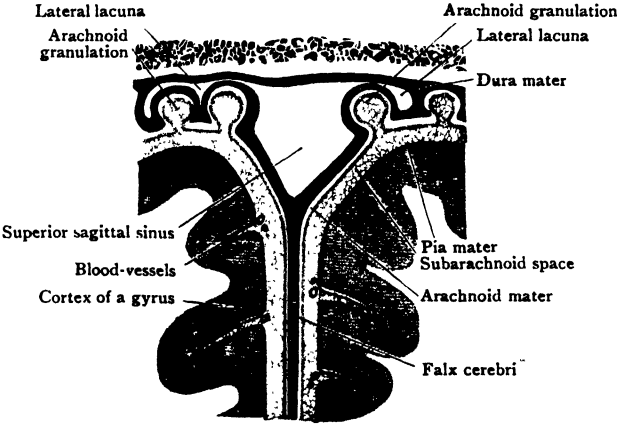


FIG. 30.—Diagram of Coronal Section through the middle portion of the Cranial Vault and subjacent Brain to show the Membranes of the Brain and the Arachnoid Granulations.

Two Layers of the Dura Mater.—Having noted the preliminary details from an examination of the outer surface of the dura mater, the students are in a position to understand that the membrane does not belong entirely to the brain. It performs a double function: (1) it acts as an internal periosteum to the bones that bound the cranial cavity; and (2) it protects and supports the different parts of the brain. Accordingly, it is composed of two strata—an outer and an inner—which, in most localities, are firmly adherent, but they can usually be easily demonstrated in the dissecting-room.

Along certain lines the two layers separate from each other. In some places they separate to form blood-channels termed *venous sinuses*; in other places they separate not only in order to form blood-channels but also that the inner layer may form strong partitions which pass in between certain parts of the brain; and by those partitions the cranial cavity is divided into compartments that communicate freely with one another, each holding a definite division of the brain (Figs. 34, 35).

The points mentioned must now be confirmed.

***Dissection.*—Begin by tilting the head forwards. Support it in that position, and make an incision through the dura mater on each side of the superior sagittal sinus along its whole length. From the mid-point of each incision, make another cut through the dura mater downwards to the cut margin of the skull immediately above the auricle (Fig. 31). The dura mater will then be divided into a median strip containing the superior sagittal sinus, and four triangular flaps. Turn the flaps downwards over the cut margin of the skull (as on the left side in Fig. 31). In that position they cover the sharp edge of the bone and prevent laceration of the brain and injury to the fingers during its removal.**

Subdural Space.—The subdural space is the capillary interval between the dura mater and the arachnoid mater (Figs. 28 and 30). It contains a very small quantity of serous fluid which moistens the opposed surfaces of the membranes.

A striking contrast between the two surfaces of the dura mater will be noted. The external surface is rough and flocculent; the internal surface is smooth and glistening.

Superior Cerebral Veins.—After the dura mater is reflected, the veins of the upper part of the brain are seen shining through the arachnoid mater. They are lodged, for the most part, in grooves on the surface, and those at present visible run upwards towards the median plane. When they reach the superior sagittal sinus they turn forwards, and run along the side wall of the sinus for some distance before they open into it.

***Dissection.*—Open into the superior sagittal sinus by running a knife through its upper wall from behind forwards.**

Superior Sagittal Sinus (Figs. 31, 34).—This long sinus begins in front of the crista galli, where it communicates, through the foramen cæcum, with the veins of the frontal sinus, and, occasionally, with the veins of the nose. It extends backwards to the internal occipital protuberance, grooving the cranial vault in the median plane; and at the right side of the protuberance it becomes continuous with the right transverse sinus. Its lumen, which is triangular in cross-section, is very small anteriorly, but expands greatly posteriorly. Arachnoid granulations bulge into the sinus; and its inferior angle is crossed by a number of minute bands.

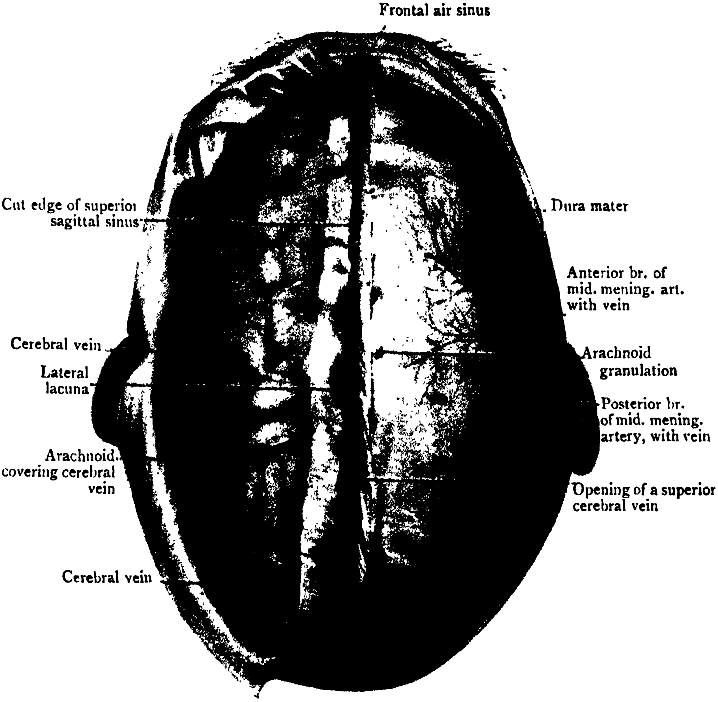

Frontal air sinus
Cut edge of superior sagittal sinus
Cerebral vein
Lateral lacuna
Arachnoid covering cerebral vein
Cerebral vein
Dura mater
Anterior br. of mid. mening. art. with vein
Arachnoid granulation
Posterior br. of mid. mening. artery, with vein
Opening of a superior cerebral vein

FIG. 31.—Superior Sagittal Sinus; Dura Mater; Middle Meningeal Artery and Vein; Arachnoid Mater and Superior Cerebral Veins.

Lacunæ Laterales.—On each side of the sinus, there are three or more clefts between the two layers of the dura mater. Those clefts are called **lacunæ laterales**; they contain blood, and they open into the sinus; the largest of them is about an inch in diameter, and it overlies the part of the surface of the brain which contains the motor area for the lower limb of the opposite side. These lacunæ receive meningeal and diploic veins ; and they may, as they increase in size with age, make shallow depressions on the skull vault.

Entrance of Veins.—The superior cerebral veins open into the sinus (passing beneath the lacunæ when they encounter them) ; and they pour their blood into the sinus in a direction contrary to that in which the blood flows within the channel ; for the blood in the sinus flows backwards, but the terminal portions of the veins are directed forwards—some of them running forwards for half an inch or more between the sinus and the medial surface of the cerebral hemisphere before they enter the sinus.

Relation of Arachnoid Granulations to Superior Sagittal Sinus and Lateral Lacunæ.—When the granulations bulge into the sinus or into the lateral lacunæ, they stretch the lateral wall or the floor of the space and push it before them as a continuous covering, and, when they project still farther and encroach upon the bones of the skull, they are covered also by a thin expansion of the roof of the space. Examine the middle of the vault of the detached skull-cap, and look for the shallow depressions made by the lacunæ and the smaller, clean-cut pits made by the granulations.

***Dissection.*—In order to expose the *falx cerebri*, divide the superior cerebral veins on each side, and displace the upper parts of the hemispheres of the brain sidewards.**

Falx Cerebri (Figs. 34, 35).—The falx cerebri is a sickle-shaped reduplication of the inner layer of the dura mater which descends between the two cerebral hemispheres. Anteriorly, it is narrow, and is attached to the crista galli ; the anterior part is often cribriform, and may even resemble lacework. As it passes backwards it increases in depth, and its convex, upper border is attached to the lips of the sagittal groove on the vault of the skull. The posterior part of the lower border is attached, in the median plane, to the upper surface of another fold of the dura mater called the tentorium cerebelli, which roofs over the posterior cranial fossa (Figs. 35, 36) ; the rest of the lower border is free and concave, and it overhangs a part of the brain, called the corpus callosum, which connects the two halves of the cerebrum ; but it is not in contact with the corpus callosum except to a very slight extent posteriorly. Along its borders the two layers of the falx cerebri separate to enclose blood-sinuses—the *superior sagittal sinus*, in its convex, upper margin ; the

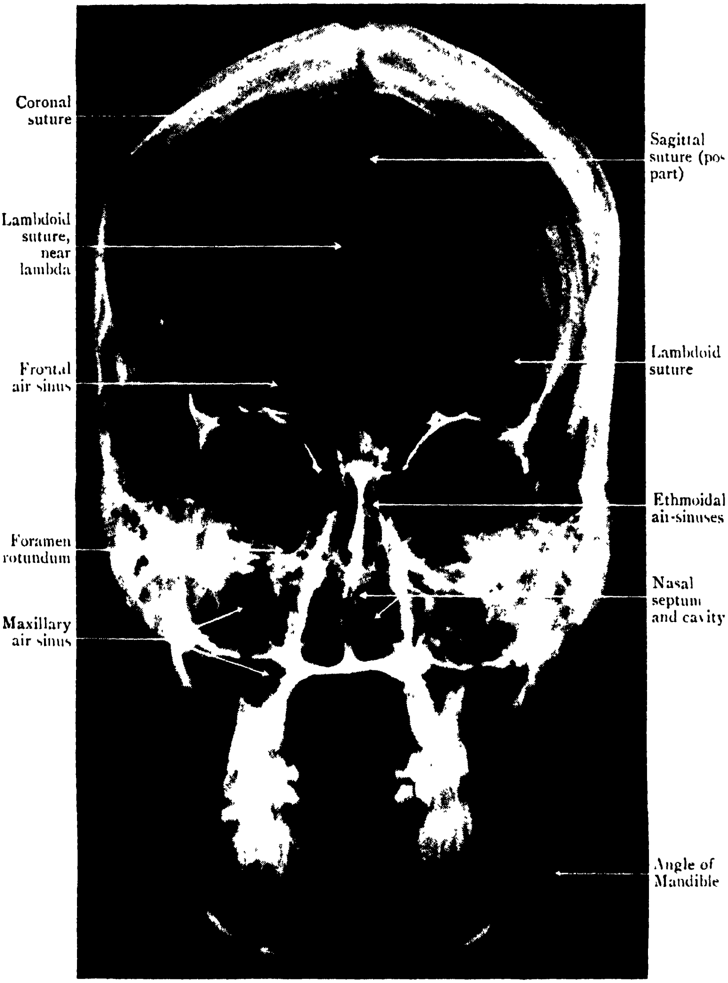
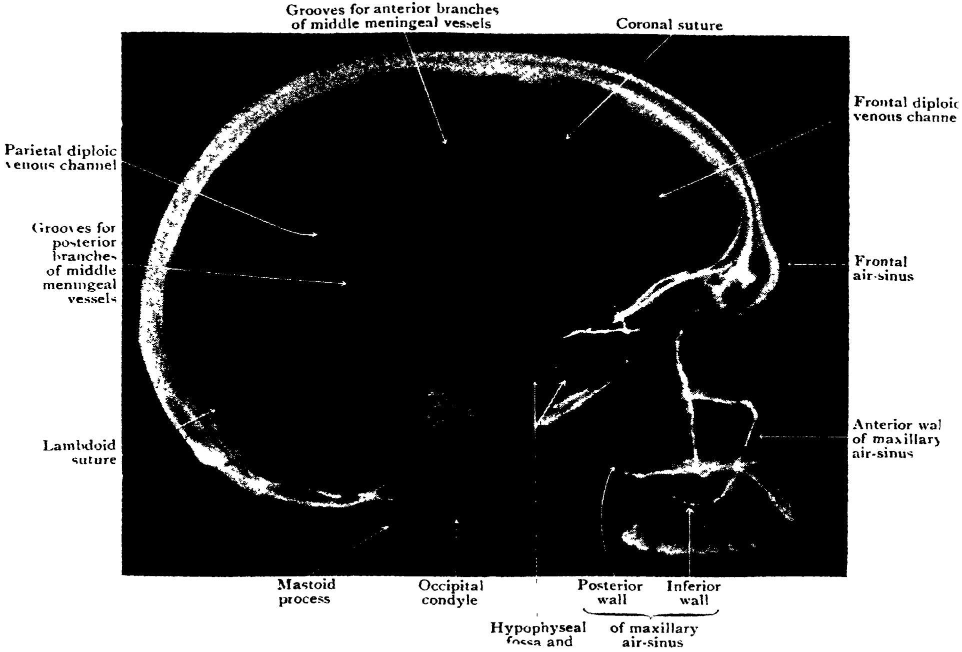


FIG. 32.—Antero-Posterior Radiograph of Male Skull.

Note that in this skull the septum between the two frontal sinuses is broad; and compare with Fig. 39.

PLATE II


Grooves for anterior branches of middle meningeal vessels
Coronal suture
Frontal diploic venous channe
Parietal diploic venous channel
Grooves for posterior branches of middle meningeal vessels
Frontal air-sinus
Anterior wal of maxillary air-sinus
Lambdoid suture
Mastoid process
Occipital condyle
Posterior wall
Inferior wall
of maxillary air-sinus
Hypophyseal fossa and

inferior sagittal sinus, in its concave, free margin ; and the *straight sinus*, in its attachment to the tentorium cerebelli.

Removal of the Brain.—There are more methods than one of removing the brain. Alternative methods are given on p. 101 ; but, unless there is some special reason for preserving the brain entire, students who are dissecting the part for the first time should take the following steps :—

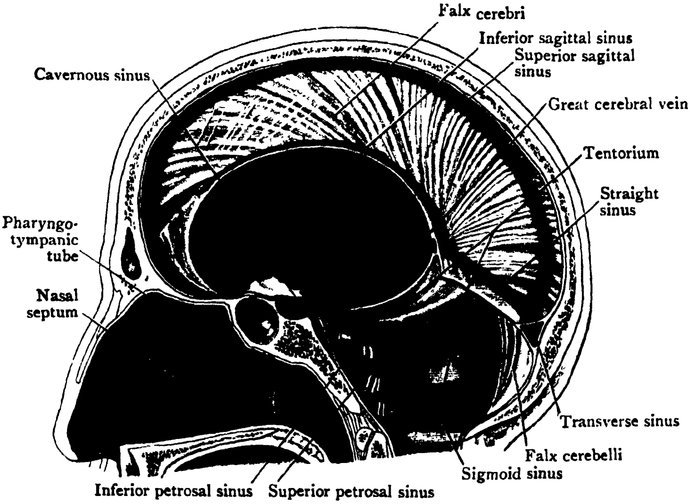


FIG. 34.—Sagittal Section through the Skull, a little to the left of the median plane, to show the processes of Dura Mater.

V. Trigeminal nerve.
VII. Facial nerve.
VIII. Auditory nerve.
IX. Glosso-pharyngeal nerve.
X. Vagus nerve.
XI. Accessory nerve.
XII. Hypoglossal nerve.

Dissection.—**Detach the falx cerebri from the crista galli and pull the falx backwards. Next, remove the block upon which the head rests, support the occiput and posterior part of the brain with the left hand, and let the head drop well downwards. In all probability, the frontal parts of the brain will fall away by their own weight from the anterior cranial fossa, and perhaps carry with them a pair of small structures called the *olfactory bulbs*. Should they remain in position, however, gently raise them with the fingers, and with the handle of the knife separate the olfactory bulbs from the recess in the floor of the fossa near the crista galli. As the bulbs are raised, the *olfactory nerves*, which pass from the nasal cavity to the bulbs through the cribriform plates, will be torn across.**

The *optic nerves*—large, round and white—then come into

view, as they pass towards the optic foramina. Divide the optic nerves, and the *internal carotid arteries* will be exposed. Farther back, in the median plane, the *infundibulum* will be seen ; it is a hollow, conical process which extends from the base of the brain to an appendage of the brain, called the *hypophysis*, which lies in the hypophyseal fossa of the skull.

Divide the carotid arteries and the infundibulum. The edge of bone seen and felt behind the infundibulum is the upper border of the *dorsum sellæ*. The pair of nerves seen passing forwards by the sides of the dorsum sellæ are the *oculomotor nerves* ; do not touch them at present. A little more laterally, and on a slightly lower plane, the free border of the tentorium cerebelli is seen.

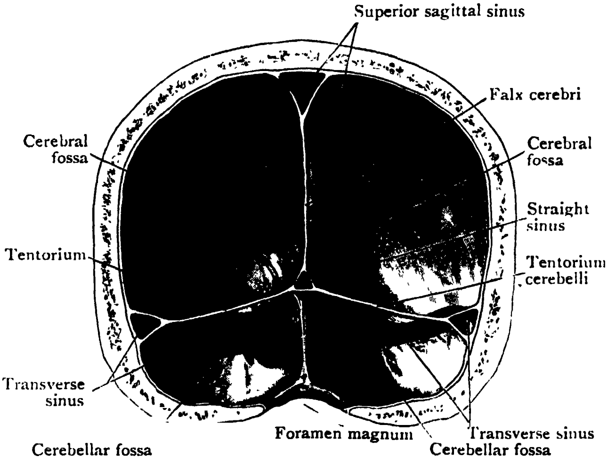


FIG. 35.—Coronal Section through the Cranial Cavity in a plane which passes through the posterior part of the foramen magnum. The posterior part of the cranial cavity is depicted.

Identify the *lesser wing of the sphenoid.* It is the bone in the posterior part of the floor of the anterior cranial fossa—lateral to the optic nerve and the cut end of the internal carotid artery—and it has a free, overhanging posterior margin. The part of the brain wedged in under the lesser wing is the anterior end of the *temporal lobe.* Disengage the temporal lobe from under the lesser wing ; raise the lobe from the floor of the middle cranial fossa and from the tentorium cerebelli ; and note a thick stalk —the *mid-brain*—which ascends from the posterior cranial fossa to join the cerebrum.

Push the knife backwards, along the side of the mid-brain, immediately above the level of the oculomotor nerve, and cut through the mid-brain from its lateral surface inwards to the median plane, slanting the knife so that it is in the same plane as the surface of the tentorium cerebelli. Repeat the operation on the opposite side. Then, turn the cerebral hemispheres

backwards ; divide a large vein—the *great cerebral vein*—that emerges from the brain immediately above the mid-brain. Remove the cerebrum (and upper part of mid-brain) from the skull, dividing the veins at the sinuses.

If the brain is firm, place it at once in a jar containing a 5 per cent. solution of formalin ; if it is soft—but preservable —fit it into the skull-cap in order that it may retain its shape, and place it in a 10 per cent. solution of formalin.

Alternative Methods of Removing the Brain.—(1) Students who are dissecting the Head and Neck for the second time, and have some knowledge of the position and characters of the parts of the brain, may remove the two cerebral hemispheres separately. By doing so, they obtain a full viewof the undisturbed falx cerebri, and can study its position and connexions more satisfactorily.

***Dissection.*—Pull the left hemisphere gently away from the falx cerebri, and divide the cerebral veins that enter the superior sagittal sinus. Pull the hemisphere still farther away ; pass the knife downwards along the side of the falx and bisect the structures that unite the two hemispheres, and also the upper part of the mid-brain. Remove the block that supports the head, and let the head drop downwards. Disengage the frontal lobe and olfactory bulb from the anterior cranial fossa, pull them backwards, and divide the optic nerve, the internal carotid artery, and the half of the bisected infundibulum. Disengage the temporal lobe from the middle cranial fossa, and lift it off the tentorium. Pass the knife medially and upwards in the same plane as the tentorium, and cut through the mid-brain as far as the median plane. Then, divide the posterior cerebral artery, and remove the hemisphere. After studying the cut surfaces of the brain *in situ*, repeat the operation on the other side.**

(2) To remove the brain entire is less instructive than to remove its main parts separately, but it is sometimes desirable to do so, and it is the method usually adopted in the post-mortem room.

***Dissection.*—Detach the falx cerebri from the crista galli and pull the falx backwards.**

Remove the block upon which the head has been resting—supporting the occiput and the posterior part of the brain with the left hand—and let the head drop well downwards. The weight of the frontal lobes will probably draw them away from the floor of the anterior cranial fossa, and possibly the *olfactory bulbs* may be carried with them. If the olfactory bulbs remain in position, gently raise them with the handle of the scalpel, tearing across the *olfactory nerve filaments*.

As the frontal lobes are pressed backwards, the *optic nerves* come into view. When they are divided, the *internal carotid arteries* will be exposed. Farther back, in the median plane, the *infundibulum* will be seen passing through a hole in the dura mater of the floor of the cranial cavity to join the *hypophysis*. More laterally, on each side, the *oculomotor nerve* will be seen. Sever each of the structures mentioned in turn.

On the lateral side of each oculomotor nerve there is the free border of the tentorium cerebelli. Turn that margin aside

with the point of the knife, and divide a small nerve—the *trochlear*—which then comes into view.

The head must, in the next place, be turned forcibly round, so that the face is directed over the left shoulder. Raise the posterior part of the right cerebral hemisphere with the fingers, and note that it rests on the tentorium cerebelli. Divide the tentorium along its attached border, taking care not to injure the cerebellum.

Next, turn the head so as to bring its left side uppermost, and treat the tentorium on that side in the same manner. Now, let the brain fall well backwards; the pons and medulla will then be drawn away from the anterior wall of the posterior cranial fossa, and the nerves in the fossa will come into view. **They are :—(1) the two roots of the *trigeminal nerve*, perforating the dura mater near the apex of the petrous temporal bone ; (2) the *abducent nerve*, piercing the dura mater behind the dorsum sellæ ; (3) the *facial nerve* and the *auditory nerve*, disappearing into the internal auditory meatus ; (4) the *glosso-pharyngeal*, the *vagus*, and the *accessory nerves*, leaving the skull through the jugular foramen ; and (5) the two parts of the *hypoglossal nerve*, piercing the dura mater separately over the anterior condylar canal.**

Each in turn will be displayed upon each side. Divide them in the order mentioned, but leave the *right accessory nerve* intact within the cranium by dividing its roots close to the medulla oblongata, and remove only the *left* one with the brain. The accessory nerve is readily recognised because its spinal part ascends through the foramen magnum.

Now, thrust the knife into the vertebral canal, and divide the *spinal cord* and the *vertebral arteries*. Then, sever the lower part of the right accessory nerve, and the roots of the first pair of spinal nerves. When that has been done, let the head fall well downwards, gently dislodge the medulla oblongata and cerebellum ; and the whole brain can be removed. The *great cerebral vein* is ruptured as the brain is removed, for it emerges from the interior of the brain and passes to the middle of the free border of the tentorium to enter the straight sinus.

Finally, replace the tentorium.

Parts seen after Removal of Cerebrum.—Examine the parts exposed, and note their relative positions (Fig. 36).

In front, there is the floor of the *anterior cranial fossa* ; behind it, on a lower plane, the *middle fossa* ; and, still farther back, the sloping surface of the *tentorium cerebelli.*

The *crista galli* stands as a landmark in the median plane anteriorly. On each side of it, there is the *cribriform plate* of the ethmoid, through which the olfactory nerves enter the cranial cavity from the nose to end in the olfactory bulb. The bed from which the olfactory bulb was dislodged extends a little beyond the lateral row of foramina in the plate ; and, still more laterally, the part of the floor of the anterior cranial fossa which forms the roof of the orbit bulges upwards as an uneven convexity. This portion ends posteriorly as a sharp margin—the posterior border of the *lesser wing of the sphenoid*, which overhangs the middle fossa. The margin is covered with

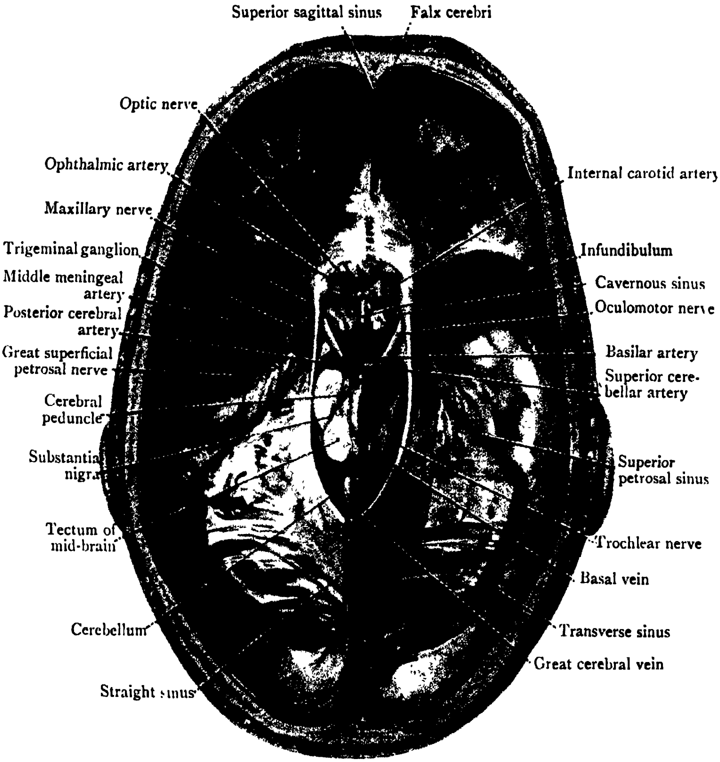


FIG. 36.—Interior of the Cranium after removal of the Cerebrum. The transverse, straight, and superior petrosal sinuses have been opened, and the dura mater has been removed from the floor of the left middle fossa.

a thickening of the dura mater in which a small venous channel, called the *spheno-parietal sinus*, runs medially; and the margin ends medially in a blunt, flat projection called the ***anterior clinoid process***.

At the medial side of the anterior clinoid process, note the ***optic nerve*** and ***internal carotid artery***, and, also, the ***ophthalmic artery***, which springs from the carotid and runs forwards under the optic nerve. A little farther back, in the median plane, there is the divided *infundibulum* descending into the hypophyseal fossa. Behind that, there is the upper edge of the *dorsum sellæ*; the edge ends, on each side, as a prominence called the *posterior clinoid process.*

The area between the four clinoid processes is occupied by a fold or reduplication of the inner layer of the dura mater called the *diaphragma sellæ.* It roofs over the hypophyseal fossa and binds down the *hypophysis* of the brain, which lies in the fossa; the infundibulum passes through a round aperture in its centre to join the hypophysis; and the anterior and posterior margins of the diaphragma enclose small blood-spaces called the *anterior* and *posterior intercavernous sinuses.*

Lateral to the hypophyseal fossa, the two layers of the dura mater separate to enclose a short but wide venous space called the *cavernous sinus.* More laterally, there is the floor of the lateral part of the middle cranial fossa covered with the dura mater, in which the trunk and some of the branches of the *middle meningeal artery* are visible.

The divided *mid-brain* lies in an oval gap in the tentorium, surrounded by pia mater and arachnoid mater. The *oculomotor nerves* emerge through the front of the mid-brain, and, diverging from each other, pass forwards and laterally to pierce the dura mater of the roof of the cavernous sinus. Below the interval between the two oculomotor nerves, there is a large median artery called the *basilar artery*, which ends there by bifurcating to form the *posterior cerebral arteries.* They curve backwards round the sides of the mid-brain above the oculomotor nerves, and, since they pass on to the cerebrum, they were divided when the cerebrum was removed. The pair of branches of the basilar artery that are seen curving backwards below the oculomotor nerves are the *superior cerebellar arteries.* The slender nerve seen curving forwards round the mid-brain is the *trochlear nerve*; it pierces the dura mater a little behind the oculomotor nerve, and runs forwards in the wall of the cavernous sinus. A vein called the *basal vein* curves backwards round the mid-brain below the trochlear nerve. It is difficult to detect it when it is empty, but it is easily seen when well filled with blood as it was in the specimen depicted in Fig. 36. It ends in the *great cerebral vein*, which was divided as it came out of the cerebrum above the mid-brain. The terminal part of the great cerebral vein is now seen behind the mid-brain. It pierces the dura mater in the middle of the free margin of the tentorium, and unites with the inferior sagittal sinus to form the *straight sinus*, which lies in the line of union of the tentorium cerebelli and the falx cerebri.

The dissectors will now examine the connexions of the tentorium cerebelli.

Tentorium Cerebelli.—This wide and sloping fold of the inner layer of the dura mater receives its name from its resemblance to a tent. Its base is attached to the rim of the posterior cranial fossa. From its base, it slopes upwards and inwards, roofing over the fossa and rising to a peak.

It has two margins :—(1) the peripheral or basal margin, and (2) the boundary of the oval opening that represents the doorway of the tent, and is occupied by the mid-brain and the peak of the cerebellum (Fig. 36).

At the *peripheral margin*, the two layers of the tentorium separate from each other to be attached :—(1) to the lips of the horizontal groove on the cranial wall for the transverse sinus, and (2) to the lips of the groove for the superior petrosal sinus along the upper border of the petrous temporal bone ; from the apex of the petrous temporal, the margin is prolonged as a slight ridge that ends (3) on the posterior clinoid process.

The *central margin*, being the boundary of the doorway, is a free edge where the two layers of the tentorium are continuous with each other. On each side, it crosses above the peripheral margin at the apex of the petrous temporal bone, and is prolonged forwards as a ridge, on the upper wall of the cavernous sinus, to end on the anterior clinoid process.

The trochlear nerve enters the substance of the inner layer of the dura mater at the point where the two margins cross ; and the oculomotor nerve enters the dura a little farther forwards — between the two margins after they have crossed.

The falx cerebri is connected with the tentorium along its median line. The two layers of the falx separate from each other to become continuous with the two halves of the upper layer of the tentorium ; and, as they separate, they and the lower layer of the tentorium enclose the straight sinus. The falx, being attached to the cranial vault, braces up the tentorium and makes it tense, so that it effectively keeps the weight of the hinder part of the cerebrum off the cerebellum.

Dissection.—**Incise the free margin of the falx cerebri, and trace the *inferior sagittal sinus* backwards and forwards.**

Open the *straight sinus* along one side by incising the falx cerebri along its line of union with the tentorium and re*moving a strip of its wall.*

Cut away the falx cerebri from the occipital bone, and, in doing so, you will open up the terminal part of the superior sagittal sinus.

Lastly, open up the *transverse sinus* and the *superior petrosal sinus* by incisions carried along the attached margin of the tentorium.

VENOUS SINUSES.—The **superior sagittal sinus** is described on p. 96.

Inferior Sagittal Sinus.—This is the narrow venous channel enclosed in the posterior two-thirds of the free border of the falx cerebri. It receives small tributaries from the falx and the middle third of the medial surface of the cerebral hemisphere; and it ends, at the angle of union of the falx and the tentorium, by joining the great cerebral vein to form the straight sinus.

Straight Sinus.—The straight sinus, so formed, extends downwards and backwards in the line of union of the falx cerebri and tentorium cerebelli, and ends at the internal occipital protuberance by becoming one of the transverse sinuses—usually the left. It receives tributaries from the posterior part of the cerebrum, from the cerebellum and from the falx cerebri.

In many bodies there is a communication between the straight sinus and the superior sagittal sinus as they bend to become the transverse sinuses. Usually the sagittal sinus becomes the right transverse sinus, and the straight sinus becomes the left; but occasionally that arrangement is reversed. Occasionally, the superior sagittal, the straight and the two transverse sinuses meet together in a common dilatation called the **confluence of the sinuses,** which lies on or near the internal occipital protuberance and makes a wide, shallow impression on the bone.

Transverse Sinus.—The transverse is a paired sinus, and is the widest and most important of the sinuses. The superior sagittal sinus is larger than the straight sinus, and whichever transverse sinus is continuous with it is usually wider than the other; but, owing to communications between the sinuses at the internal occipital protuberance, the transverse sinuses may be equal.

Origin, Course and Termination.—The transverse sinus begins at the internal occipital protuberance as a continuation of either the superior sagittal sinus or the straight sinus. It runs nearly horizontally, at first in a lateral direction and then forwards, on the cranial wall as far as the base of the petrous temporal bone; it lies in the transverse groove of the skull and in the attached margin of the tentorium, and is bounded by the two layers of the tentorium and the outer layer of the dura mater, which lines the transverse groove. At the base of the petrous temporal, it ends by leaving the tentorium and bending downwards to become the sigmoid sinus, which will be examined later.

Relations.—The transverse sinus is related superiorly to the cerebrum, and inferiorly to the cerebellum. Externally, it is related to the occipital bone opposite the superior nuchal line, and to the posterior inferior angle of the parietal bone —grooving both bones. The bone separates it from the structures attached to the nuchal line and from the vessels and nerves in the region—occipital vessels, greater occipital nerve, and branches of the lesser occipital and great auricular nerves.

Tributaries.—The transverse sinus receives (1) veins from the cerebrum and the cerebellum, (2) the occipital diploic vein, and (3) the superior petrosal sinus.

Superior Petrosal Sinus.—This is a very narrow sinus which begins in the posterior end of the cavernous sinus, runs along the upper border of the petrous temporal bone in the attached margin of the tentorium, and ends in the transverse sinus at the point where it bends down to become the sigmoid sinus.

Frontal Air-Sinuses.—The present is a convenient time to examine the frontal air-sinuses. It is probable that one or both of them were opened by the saw-cut through the frontal bone when the skull-cap was removed. If not, chip off with the chisel part of the frontal bone close to the median plane till one of the sinuses is opened: then, explore its extent with a probe, and try to pass the probe downwards into the cavity of the nose.

The frontal sinuses (Fig. 39) are a pair of cavities in the anterior part of the frontal bone, immediately above the root of the nose and the margins of the orbits. They are completely separated from each other by a bony septum, which, however, is not quite median. Each of them is about an inch in height and an inch in width. They may be smaller, especially in women, and they may be absent; on the other hand, they may be much larger—extending upwards and sidewards, and even backwards between the two tables of the roof of the orbit—and, like the other air-sinuses, they tend to become larger in old age owing to absorption of the diploë. Like the other air-sinuses, they are lined with a ciliated mucous membrane which is blended with the endosteum, and they communicate with the cavity of the nose. The funnel-like passage that leads down from the frontal sinus, through the ethmoid bone, to the nose is called the *infundibulum* (Fig. 55), and it opens into a part of the cavity of the nose called the middle meatus.

Anterior Cranial Fossa.—After the frontal sinus has been explored, examine the few small structures that lie in the floor of the anterior cranial fossa.

Dissection.*—Carefully remove the dura mater from the cribriform plate; secure and clean the *anterior ethmoidal nerve.

Ethmoidal Nerve and Vessels.—The *anterior ethmoidal nerve* is a terminal branch of the naso-ciliary nerve of the orbit. It enters the cranial cavity under a lip of bone at the middle of the lateral margin of the cribriform plate, runs forwards for a short distance, and descends through a small hole at the side of the anterior part of the crista galli to enter the cavity of the nose. Its terminal branch—the external nasal nerve—has been seen already on the surface of the external nose (p. 30).

The *ethmoidal arteries* arise in the orbit from the ophthalmic. The *anterior ethmoidal* artery accompanies the nerve. The *posterior ethmoidal* artery is smaller. It appears in the cranial cavity from under a lip of bone at the posterior end of the cribriform plate.

Meningeal Vessels in Anterior Cranial Fossa.—The *anterior meningeal arteries* are small vessels that may be seen shining through the dura mater of the floor of the anterior cranial fossa if the red injection has run into them. Those in the most lateral part of the floor are twigs from the anterior branch of the middle meningeal artery. Those more medially placed are branches of the ethmoidal arteries.

Middle Cranial Fossa.—The students will now proceed to dissect the structures that lie on the floor of the middle *cranial fossa, and will, at the same time, expose the sphenoidal air-sinuses.*

> ***Dissection.***—**Incise the margins of the aperture in the diaphragma sellæ, and dislodge the *hypophysis cerebri* from the hypophyseal fossa. Then, with chisel or bone-forceps, chip away the floor of the fossa and expose the *sphenoidal sinuses*; explore them with a probe, and pass the probe into the nose through the small openings on their anterior walls.**

Hypophysis Cerebri.—This is an exceedingly important organ in the physiology of internal secretion; among its functions is the control of body-growth. It has been called also the ***pituitary body*** from an old notion that it secreted the nasal mucus. (The English adjective "pituitary" means "mucous" and is rightly applied to the nasal mucous membrane.) It is an oval structure, about the size of a large pea, slightly flattened from above downwards. It lies in the hypophyseal fossa under cover of the diaphragma sellæ, and is connected with the tuber cinereum of the base of the brain by means of a stalk, called the infundibulum, which passes through the aperture in the diaphragma. The hypophysis has two lobes —anterior and posterior. The ***posterior lobe*** is small, and is derived from the brain, with which it is connected by the infundibulum. The ***anterior lobe*** is derived from the ectoderm of the primitive mouth, and has no direct connexion with the brain. It is much larger than the posterior lobe, which is lodged in a hollow on the back of it; and it sends a process (***pars tuberalis***) upwards in front of the infundibulum. A

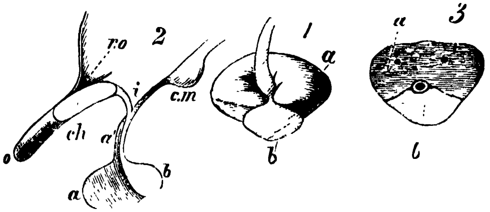


FIG. 37.—Hypophysis Cerebri (Schwalbe).
1. From behind. 2. In median section. 3. In horizontal section.

a. Anterior lobe.
a'. Pars tuberalis (anterior lobe) in front of infundibulum.
b. Posterior lobe.
ch. Optic chiasma in section.
cm. Corpus mamillare.
i. Infundibular recess in tuber cinereum.
o. Optic nerve.
ro. Optic recess of the third ventricle.

narrow cleft in the anterior lobe separates a thick *pars anterior* from a thin *pars media*, which adjoins the posterior lobe.

The hypophysis is supplied by twigs from the internal carotid arteries and the anterior cerebral arteries.

Relations.—The sphenoidal air-sinuses are below the hypophysis and in front of it; the optic chiasma is above it; the dorsum sellæ is behind it, and separates it from the basilar artery and the part of the brain, called the pons, which lies below the mid-brain; the cavernous sinuses are on each side of it, and the venous channels that connect them with each other pass both below and behind and in front of the hypophysis.

Sphenoidal Air-Sinuses (Figs. 34, 42, 108).—These are a pair of sinuses that occupy the body of the sphenoid. They are completely separated from each other by a bony septum; but the septum is never median, and the sinuses are therefore unequal. They may occupy the whole of the body of the sphenoid (Fig. 108) or only a part of it (Fig. 42); or may extend beyond the body into the roots of the greater wings and pterygoid processes, and even into the basi-occiput. Each of them has a small, round hole in its anterior wall through which it communicates with a part of the cavity of the nose called the spheno-ethmoidal recess.

Relations.—The sinuses and their relations will be seen to better advantage when the cavity of the nose is dissected but procure a split skull and note their principal relation now.

Each sphenoidal sinus is related *anteriorly* to the cavit of the nose and to the air-sinuses in the ethmoid bone. *Inferiorly*, a thick floor separates them from the cavities of th nose and naso-pharynx; and the floor is tunnelled anter posteriorly by the pterygoid canal, which transmits t vessels and nerve of the same name. *Posteriorly*, it separated by thick bone from the cranial cavity, the basil artery and the pons. A thin *roof* separates it from t intercavernous venous channels, the hypophysis, the olfacto tract and adjoining part of the cerebrum, and from the opt chiasma, which, however, is a little distance from the bon *On each side*, a thin bony wall separates it from t cavernous sinus, from the maxillary nerve along the low border of that sinus, from the optic nerve in the opt foramen, and from the posterior part of the orbit.

PLATE III

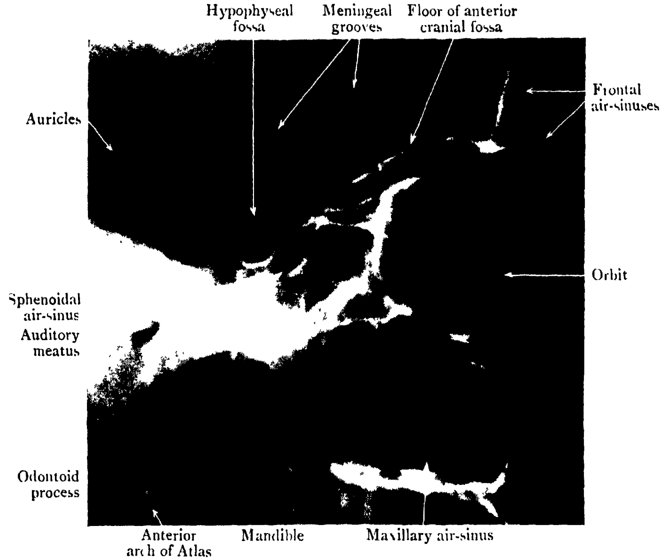


FIG. 38.—Part of Lateral Radiograph of Head of adult, showing Hypophyseal Fossa and Air-Sinuses.

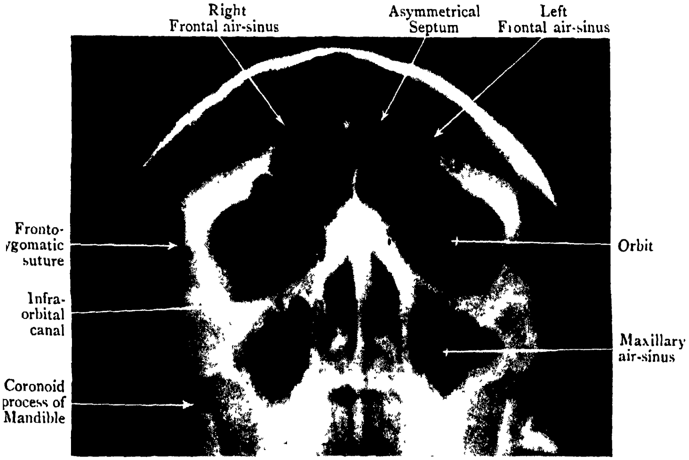


FIG. 39.—Radiograph of the Frontal Air-Sinuses of man aged 34. (Dr. J. F. Brailsford.) Note the asymmetrical position of the septum and the extension of the sinuses into the roofs of the orbits.

PLATE IV

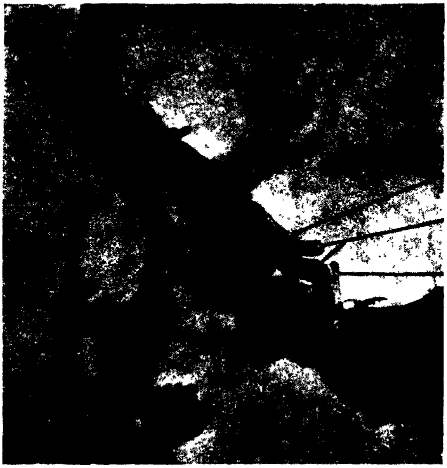

Anterior clinoid process
Internal carotid artery
Dorsum sellæ
Spheno-occipital cartilaginous joint
Floor of hypophyseal fossa

FIG. 40.—Part of Lateral Radiograph of Skull of a child (from positive print), showing the relation of the Internal Carotid Artery to the Base of the Skull. The portion of the artery shown was injected. (Dr. H. M. Traquair.)

[*Facing p.* 111

Dissection.—Incise the dura mater along the posterior margin of the lesser wing of the sphenoid in order to find the *spheno-parietal venous sinus* (a very narrow sinus), and trace the sinus medially to the cavernous sinus.

Proceed now to remove the dura mater from the floor of the middle cranial fossa. Do so with great care, for the dura mater is adherent to several of the nerves that have to be exposed.

Begin in front of the medial part of the superior petrosal sinus, taking care not to injure the sinus. Remove the dura mater from the front of the petrous temporal bone near its apex, and expose the *trigeminal ganglion*. Note the *sensory root of the trigeminal nerve* passing backwards from the ganglion, but do not disturb the root. Find the three big nerves that issue from the anterior border of the ganglion—the mandibular, the maxillary, and the ophthalmic. Trace the *mandibular nerve* downwards to the foramen ovale, and look for the *accessory meningeal artery* and a small *emissary vein*, which pass through the foramen. Trace the *maxillary nerve* forwards to the foramen rotundum. Follow the *ophthalmic nerve* into the lateral wall of the cavernous sinus, and clean it very carefully. It divides into three branches : trace them forwards to the superior orbital fissure.

As you follow the ophthalmic nerve and its branches, you probably encounter other nerves, for the trochlear, oculomotor and abducent nerves also lie in the lateral wall of the cavernous sinus. The *oculomotor* and *trochlear nerves* were identified when the cerebrum was removed. Pick them up as they enter the dura mater, pull gently on them, and thus identify them in the cavernous sinus. Preserve the margins of the holes through which the nerves enter the dura mater, in order to retain the nerves in place ; but remove the dura mater in front of that, tracing the nerves to the superior orbital fissure ; the oculomotor divides into two branches before it reaches the fissure. Remove the remains of the lateral wall of the cavernous sinus, and expose and clean the part of the *internal carotid artery* that lies in the sinus. As you do so, you will find the *abducent nerve* —a very slender nerve—near the lateral side of the artery ; trace the nerve backwards and forwards.

Now, strip the dura mater carefully from the rest of the anterior face of the petrous temporal bone, and look for the two *superficial petrosal nerves*. They are slender nerves that emerge from slits in the petrous temporal and run downwards and medially. One disappears through the base of the skull. The other, slightly larger, disappears under the trigeminal ganglion. As you follow it below the ganglion, levering up the ganglion, find the *motor root of the trigeminal nerve*, and trace it to the foramen ovale.

TRIGEMINAL NERVE.—This very important nerve is the fifth cranial nerve ; it is the thickest of the cranial nerves, and has a wide distribution. Its motor fibres supply the four muscles of mastication and four other muscles — tensor palati, tensor tympani, mylo-hyoid and anterior belly of the digastric. Its sensory fibres supply :—(1) part of the dura mater; (2) the eyeball and the other contents of the orbit; (3) the skin of the face and anterior half of the head; (4) the mucous membranes of the air-sinuses, nose, mouth and anterior two-thirds of the tongue; (5) the teeth; (6) the mandibular joint.

Like a spinal nerve, it has two roots—a sensory and a motor—and there is a ganglion on the sensory root. The sensory fibres arise in the ganglion. Their central branches emerge from it as the sensory root, which ends in the pons. Their peripheral branches emerge to form the three great divisions of the trigeminal nerve—namely, the ophthalmic nerve, the maxillary nerve and the mandibular nerve. The motor root arises in the pons and eventually joins the mandibular nerve as it leaves the skull.

The sensory and motor roots are enclosed in an adherent sheath of pia mater and a loose sheath of arachnoid mater that contains cerebro-spinal fluid. Traced from the pons towards the ganglion, the two roots cross the medial part of the upper border of the petrous temporal bone through an aperture in the dura mater which will be seen when the tentorium cerebelli is removed.

Trigeminal Ganglion (G. Semilunare).—The trigeminal ganglion lies in a shallow depression on the front of the petrous temporal bone near its apex and on the suture (or the gap) between that part of the petrous temporal and the greater wing of the sphenoid.

Relations.—It occupies a space between the outer and inner layers of the dura mater called the *cavum trigeminale*, but is enclosed in a pocket or diverticulum of the inner layer which is prolonged over it from the lips of the aperture that transmits the roots. There are therefore two layers of dura mater above it and two below it; but the two below it are fused together. The motor root and the greater superficial petrosal nerve (p. 120) pass below the ganglion. The internal carotid artery is first below it in the carotid canal, and then medial to it in the cavernous sinus; and the sympathetic plexus around the artery is connected with the ganglion by communicating filaments. The ganglion is crescentic in outline, the concavity being directed upwards and backwards. The sensory root emerges from the concave border; and the three great divisions emerge from the convex border.

Sensory Root.—The sensory root, on emerging from the ganglion, is at first wide and plexiform and lies in the depression on the front of the petrous temporal bone. Then, narrowing, it crosses the upper border of the petrous temporal below the attached margin of the tentorium and below the superior petrosal sinus, and passes horizontally backwards and slightly medially to the pons.

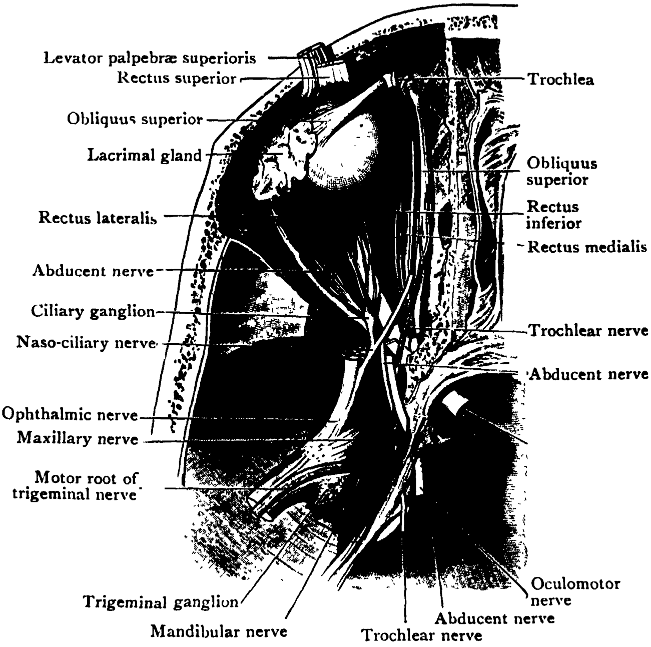


FIG. 41.—Dissection of Orbit and Middle Cranial Fossa. Both roots of the fifth nerve, with the trigeminal ganglion, are turned laterally.

Motor Root.—This root is much smaller than the sensory root. It issues from the pons, runs along the sensory root, at first on its medial side and then below it, crosses the petrous temporal and descends under cover of the ganglion and the mandibular nerve to the foramen ovale. There, it joins the mandibular nerve, which is therefore the only one of the three divisions of the trigeminal nerve that contains motor fibres.

Mandibular Nerve.—This is the largest of the three divisions of the trigeminal. It arises from the lower part of the convex border of the ganglion, and leaves the cranial cavity almost at once by descending through the foramen ovale. Before leaving it gives a *meningeal twig* to the dura mater.

Maxillary Nerve.—The maxillary nerve arises next the mandibular; passes forwards, between the two layers of the dura mater along the lower border of the cavernous sinus, closely related to the thin, bony wall of a fully-developed sphenoidal air-sinus; and leaves the cranial cavity through the foramen rotundum. Near its origin, it gives off a fine *meningeal branch* to the dura mater.

Ophthalmic Nerve.—The ophthalmic is the smallest of the three divisions. It arises from the upper, medial part of the ganglion; enters the cavernous sinus at once; runs forwards in the lateral wall of the sinus; and divides into three branches—the *frontal*, *lacrimal* and *naso-ciliary*—which pass into the orbit through the superior orbital fissure. The naso-ciliary usually arises first; then the lacrimal; and the main part of the nerve is continued as the frontal. Near its origin it gives off a minute branch to the tentorium cerebelli; and, as it runs in the sinus, it receives filaments from the sympathetic plexus around the internal carotid artery, and gives filaments to the oculomotor, trochlear and abducent nerves—the first two of which lie above it in the sinus.

Oculomotor Nerve.—The third cranial nerve supplies five of the muscles of the orbit and two muscles inside the eyeball. It arises in the mid-brain, emerges through the front of it, and has been seen (p. 104) passing forwards and laterally between the posterior cerebral and superior cerebellar arteries, and sinking into the dura mater between the margins of the tentorium after they have crossed each other. It then passes forwards in the lateral wall of the cavernous sinus, above the other nerves there, and ends by splitting into two divisions—an upper and a lower—which enter the orbit through the superior orbital fissure.

Trochlear Nerve.—The fourth cranial nerve is the thinnest of the cranial nerves and supplies only one small muscle. The nerve arises in the mid-brain, issues through the back of it, curves forwards round the side of it, and appears at the front of the brain between the posterior cerebral and superior cerebellar arteries. It enters the dura mater through a small aperture hidden under the free margin of the tentorium at or immediately behind the point where the two margins cross. The nerve then runs forwards in the lateral wall of the cavernous sinus below the oculomotor nerve and above the ophthalmic nerve. It next runs obliquely upwards across the lateral side of the oculomotor nerve, and passes through the superior orbital fissure into the orbit, where it enters the superior oblique muscle of the orbit almost at once.

Abducent Nerve.—The sixth cranial nerve, like the fourth, is very slender and supplies only one small muscle—the lateral rectus of the orbit. It arises in the pons and emerges from the brain at the lower border of the pons. It at once bends upwards behind the anterior inferior cerebellar artery and ascends for a little distance between the pons and the clivus of the skull. It then pierces the inner layer of the dura mater about half an inch below the root of the dorsum sellæ, and, running upwards and laterally between the two layers of the dura, it crosses above the inferior petrosal sinus to reach the apex of the petrous temporal bone. At that point it crosses the spheno-petrous suture under cover of a fibrous band or a spicule of bone. It then curves round the

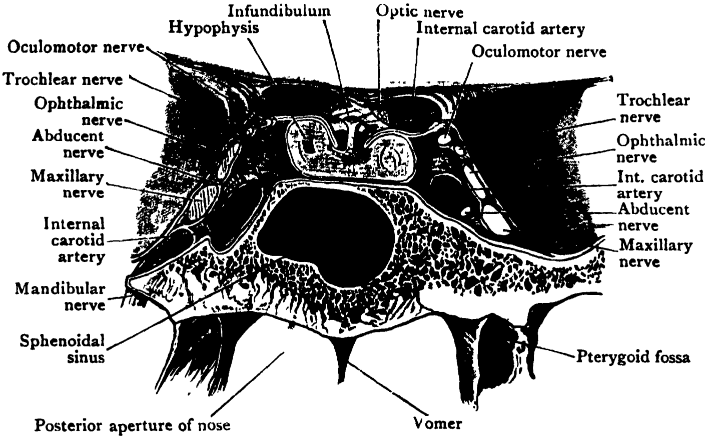


FIG. 42.—Coronal Section through the Cavernous Sinus to show the position of the Nerves in its wall. Note the branch given to the hypophysis by the internal carotid artery.

lateral side of the ascending part of the internal carotid artery to enter the cavernous sinus. In the sinus, it courses forwards along the lateral side of the horizontal part of the carotid artery ; and, leaving the sinus, it passes through the superior orbital fissure into the orbit. The only part of it at present exposed is the part in the cavernous sinus.

Communications.—While the third, fourth and sixth nerves run in the cavernous sinus, they receive sympathetic filaments from the internal carotid plexus and communicating twigs from the ophthalmic nerve.

Proprioceptive Fibres.—The third, fourth and sixth cranial nerves are essentially *motor* in function, but there is evidence that they also transmit *afferent* fibres to the brain-stem from the muscles which they supply.

Spheno-Parietal Sinus.—This is a small and unimportant sinus. It lies along the posterior border of the lesser wing of the sphenoid, and ends in the cavernous sinus.

Cavernous Sinus.—The cavernous sinus is an important sinus. Not as a venous channel (although its connexion with the ophthalmic veins gives it a measure of importance), but because of its intimate relationship to important parts—to the sphenoidal air-sinus, the hypophysis, the internal carotid artery, the oculomotor, trochlear and abducent nerves, the ophthalmic and maxillary divisions of the trigeminal nerve, and the trigeminal ganglion.

Position and Characters.—It is a short, wide channel that lies on the side of the body of the sphenoid, extending from the medial end of the superior orbital fissure to the apex of the petrous temporal bone. Like the other venous sinuses, it is formed by the separation of the two layers of the dura mater and is lined with endothelium ; but its cavity is traversed by numbers of delicate, interlacing fibrous threads that break it up into a large number of intercommunicating " caverns " from which the sinus derives its name.

Tributaries and Communications.—At its anterior end it receives the *ophthalmic vein* or veins and the *spheno-parietal sinus.* Its posterior end is connected with the *superior* and *inferior petrosal sinuses.* Medially, a number of small *intercavernous sinuses* connect it with its fellow ; one of them passes through the anterior margin of the diaphragma sellæ, another through the posterior margin, and the others pass below the hypophysis. Superiorly, it receives one or more small cerebral veins and one large one—the *superficial middle cerebral vein.* Inferiorly, it communicates with venous plexuses outside the skull by means of *emissary veins* : one emissary vein passes through the carotid canal to connect it with the pharyngeal plexus ; another passes through the foramen ovale or through the emissary sphenoidal foramen (Vesalius), when that foramen is present, and connects it with the pterygoid plexus.

Relations.—The relations of the sinus are important. The *sphenoidal air-sinus* is below and medial to it. The *hypophysis* is closely related to its upper margin. The *trigeminal ganglion* is immediately lateral to its posterior end. The *maxillary nerve* runs forwards along its lower border. The *oculomotor, trochlear* and *ophthalmic* nerves are embedded in its lateral wall, in that order from above downwards. The *internal carotid artery* and the *abducent nerve* are in the lower part of the sinus, shut off from its cavity merely by the endothelium—the nerve lying on the lateral side of the artery, at a lower level than the other nerves in the sinus. Superiorly, it is related to parts of the brain called the *optic tract* and the *uncus,* and also to the *internal carotid artery* again, after the artery has left the sinus and is curving backwards to its termination.

Intracranial Part of Internal Carotid Artery.—This artery runs a very sinuous course after it enters the cranial cavity. Examine the base of a skull: the greater part of the course of the artery is clearly marked by a wide, shallow sinuous groove on the side of the body of the sphenoid.

Course, Relations and Termination.—Having ascended through the upper part of the neck to the base of the skull, it traverses the carotid canal, crosses the foramen lacerum, and, bending upwards to enter the cranial cavity at the apex of the petrous temporal, it at once pierces the outer layer of the dura mater and enters the cavernous sinus. After a short ascent, it bends at right angles and runs forwards along the side of the body of the sphenoid to the root of the lesser wing. There, it bends sharply upwards and leaves the cavernous sinus by piercing the inner layer of the dura mater at the medial side of the anterior clinoid process, immediately behind the entrance of the optic nerve into the optic foramen. It pierces the arachnoid mater immediately after piercing the dura ; and now, bending again, it runs backwards for a short distance above the cavernous sinus (Fig. 55). Finally, it bends upwards again and ends by dividing into the anterior and middle cerebral arteries; this division takes place in the vallecula of the cerebrum below a part of the brain called the anterior perforated substance. During its course in the cranial base and cavity it is surrounded by the internal carotid plexus of sympathetic nerves. When the cerebrum was removed the artery was severed immediately after its exit from the cavernous sinus.

Branches in the Skull.—(1) Small twigs to the dura mater, the trigeminal ganglion and the hypophysis arise in the cavernous sinus. (2) The ophthalmic arises immediately after it leaves the sinus. (3) The posterior communicating, the anterior choroidal and its two terminal branches are given off when it reaches the brain.

The dissectors will complete the study of the contents of the middle cranial fossa by examining the meningeal vessels and the petrosal nerves. These nerves have been dissected already (p. 111), but the vessels have to be exposed.

Dissection.—Find the _middle meningeal artery_ at the foramen spinosum; trace its trunk and branches, removing the dura mater from them; then, look for small meningeal arteries that enter the middle cranial fossa through the superior orbital fissure.

MENINGEAL VESSELS IN MIDDLE CRANIAL FOSSA.—It was explained, when the dura mater was exposed, that the meningeal vessels are embedded in the outer layer of the dura, but, being thicker than the dura, they stand out in relief on its surface, and groove the inner table of the skull bones; and, though they are called "meningeal," their branches are distributed chiefly to the bone. Their intimate relation to the bone is a source of danger to them, for they are liable to be torn when the skull is fractured—the veins more so than the arteries, for they are external to the arteries.

There are several meningeal arteries in the middle cranial fossa, but the one to which most attention should be given is the *middle meningeal.*

Middle Meningeal Artery.—This artery is not large, but it is important. The commonest source of meningeal hæmorrhage is rupture of its anterior branch; and it is important also because that branch is opposite the motor area of the brain and is encountered in an operation on that area. It arises from the maxillary artery in the infratemporal fossa, where it will be dissected later ; but the important part of its course is inside the skull. The course of its trunk and main branches inside the skull is not difficult to follow, and they can be seen through the dura mater if they are well injected.

Course and Branches.—The middle meningeal artery ascends from the maxillary artery and enters the skull through the foramen spinosum. It then runs forwards and laterally on the floor of the cranial cavity, and, at a variable point, it divides into an anterior and a posterior branch.

The *posterior branch* sweeps backwards and upwards on the side wall of the cranial cavity towards the lambda—*i.e.* the point on the skull at the apex of the occipital bone.

The *anterior branch* is larger and more important. It ascends on the side wall to a point near the lateral end of the lesser wing of the sphenoid, opposite the point on the outside of the skull called the *pterion*, and then runs obliquely upwards and backwards towards the mid-point between the root of the nose and the occipital protuberance. Opposite the pterion, it grooves the bone very deeply, and, in some skulls, it even disappears into a bony tunnel to emerge again a little distance above the pterion.

The branches of those two divisions spread out widely in the arborescent grooves on the inner table of the skull ; and one or more slender branches which arise from the anterior division near the pterion run forwards on the floor and side wall of the anterior cranial fossa.

The *middle meningeal vein* accompanies the artery through the foramen spinosum, and ends in the pterygoid plexus.

Surface Anatomy.—The operating surgeon has to know the lines on the outside of the head opposite which the main branches of the artery lie. Therefore, while studying the artery, procure the base of a skull—or, better still, one-half of a bisected skull. Follow the course of the grooves made by the artery and its branches on the inside of the skull ; mark in lines opposite them on the outside of the skull ; and then, as it were, translate them to your partner's head. (See instructions and illustrations at the end of this volume.)

Smaller Meningeal Vessels in Middle Cranial Fossa.—The *accessory meningeal* is an occasional artery that arises, below the skull, from the middle meningeal or from the maxillary artery ; it enters the skull through the foramen ovale, and supplies the trigeminal ganglion and the dura mater near it. The *meningeal branches of the ophthalmic* and *lacrimal arteries* are small arteries that arise in the orbit and run backwards through the superior orbital fissure to supply the dura mater of the anterior part of the middle fossa. Occasionally, the meningeal branch of the lacrimal is a large artery that takes the place of the anterior branch of the middle meningeal. One of the *meningeal branches of the ascending pharyngeal* artery enters the skull through the foramen lacerum and ends in the trigeminal ganglion and the adjacent dura mater.

Petrosal Nerves.—There are four pairs of petrosal nerves :—*deep* ; *external* ; *greater superficial* ; and *lesser superficial.* Their functions are not fully known, but some of them are concerned with the sense of taste and with the secretory activities of the lacrimal and parotid glands. They are all very slender.

Greater Superficial Petrosal Nerve.—This nerve arises from the facial nerve in the substance of the petrous temporal bone. It emerges from the bone through a slit in its anterior surface, runs downwards and medially in a groove on the bone, passes below the trigeminal ganglion and enters the foramen lacerum, where it joins the deep petrosal nerve.

Deep Petrosal Nerve.—The deep petrosal nerve arises in the foramen lacerum from the sympathetic plexus around the internal carotid artery, and at once joins the greater superficial to form the *nerve of the pterygoid canal.* That nerve runs forwards through the root of the pterygoid process, near the floor of the sphenoidal sinus, and enters a space called the pterygo-palatine fossa ; it ends there in a ganglion, called the *spheno-palatine ganglion*, which is suspended from the maxillary nerve.

Lesser Superficial Petrosal Nerve.—This small nerve is formed in the petrous temporal bone by the union of two roots. One root springs from the facial nerve ; the other comes from a network of nerves in the middle ear called the tympanic plexus, and contains fibres of the glossopharyngeal nerve. The slender nerve, so formed, emerges through the anterior face of the petrous temporal a little lateral to the greater superficial petrosal nerve, runs downwards and medially, leaves the skull through a small hole (unnamed) near the foramen ovale, and ends in a ganglion, called the *otic ganglion*, which lies on the medial side of the mandibular nerve.

External Petrosal Nerve.—The external petrosal nerve is so slender that it is seldom found—and may not always be present. It arises from the sympathetic plexus around the middle meningeal artery, and runs backwards along the greater superficial petrosal nerve to the facial nerve. It is accompanied by the *superficial petrosal artery*—a branch of the middle meningeal artery.

Posterior Cranial Fossa.—The dissectors will now cut away the tentorium, and, after removing the hind-brain, will *study the structures in the posterior cranial fossa.*

***Dissection.*—On each side, cut the free border of the *tentorium* immediately behind the point where it crosses the attached border, and divide the *trochlear nerve* by the same incision ;**

and then cut through the tentorium along its attached margin, taking care to leave a bridge across the roots of the trigeminal nerve (Fig. 43). Now, look for a pair of veins, called the *basal veins*, that curve backwards round the sides of the mid-brain, and divide them where they join the great cerebral vein. Then, raise the anterior part of the tentorium, pass the knife backwards beneath it, and cut through a small fold of dura mater, called the *falx cerebelli*, which is attached to the posterior part of the tentorium in the median plane. The tentorium is now free. Remove it to expose the cerebellum.

Divide the *oculomotor nerves*. Press the mid-brain and the pons backwards to expose the trigeminal and abducent nerves. Divide each *trigeminal nerve* near the upper border of the petrous temporal. The *abducent nerve* is the slender nerve that is medial to the trigeminal and at a deeper level; divide it also. Press the pons and cerebellum still farther back, and cut the *facial* and *auditory nerves* as they enter the internal auditory meatus. The nerves below that are the *glosso-pharyngeal*, the *vagus* and the *accessory*. Divide each of them in turn except the *right accessory*, which should be left in the skull. Now, look for the *hypoglossal nerve* (which is still deeper and more medial), and cut it also.

Press the pons still farther back, and bring the front of the *medulla oblongata* into view, and also the pair of large arteries related to it—the *vertebral arteries*. Pass the knife downwards, in front of the medulla oblongata, into the vertebral canal; cut firmly backwards from side to side, and divide the spinal cord and the vertebral arteries. Then, with a slender knife or fine-pointed scissors, divide the roots of the *right* accessory nerve and the roots of the first pair of cervical nerves. Lastly, pass two fingers downwards in front of the medulla oblongata, lift the hind-brain out of the skull, and place it in the jar with the rest of the brain.

Parts seen after Removal of Hind-Brain.—The dissectors will now examine the structures which they have divided or have exposed.

The upper end of the *spinal cord* is seen in the vertebral canal. On each side, it is attached to the margin of the foramen magnum by the first tooth of the *ligamentum denticulatum*. The *vertebral artery* is in front of the ligamentum; and, still farther forwards, the bundles of the anterior root of the *first cervical nerve* may be seen. The two parts of the *hypoglossal nerve* are seen at a higher level as they pierce the dura mater on their way to the anterior condylar canal. The spinal root of the *accessory nerve* ascends through the foramen magnum behind the ligamentum denticulatum, and turns laterally over the margin of the foramen magnum to join the cranial root and the *vagus nerve*; it then passes with them through an aperture in the dura mater that overlies the jugular foramen. The *glosso-pharyngeal nerve* pierces the dura mater, immediately above the vagus, opposite a notch on the anterior margin of the jugular foramen. A little above the glosso-pharyngeal nerve, the ***auditory nerve*** and the two roots of the ***facial nerve*** are seen entering the internal auditory meatus—the facial above the auditory. The sensory root of the facial is very slender, but if you lift up the motor root, you will find it between the motor root (which is the main part of the facial) and the auditory nerve. The two roots

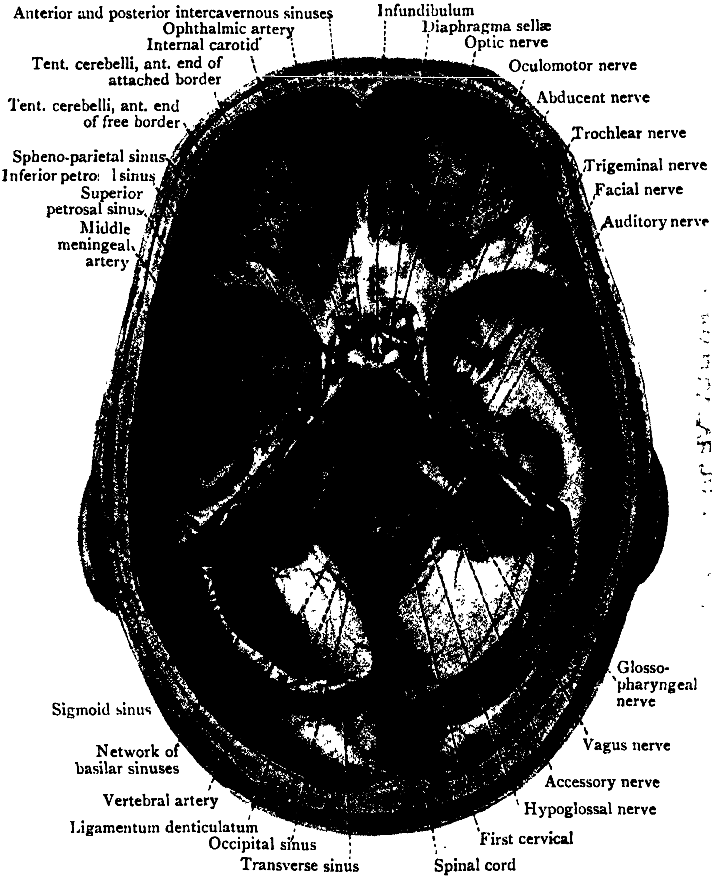


FIG. 43.—Dissection of the Floor of the Cranial Cavity after removal of the Brain.

of the *trigeminal nerve* pass into the cavum trigeminale through an opening in the dura mater above and antero-medial to the auditory meatus (Fig. 44). The *abducent nerve* pierces the dura mater a little distance below and medial to the trigeminal nerve. The *trochlear nerve* has already been seen entering the dura of the lower surface of the free edge of the tentorium at or near the point where that edge crosses the attached border.

The *vertebral artery* pierces the spinal dura mater near the skull, and enters the cranial cavity through the foramen magnum, where it was cut; as it enters the foramen, it lies in front of the first tooth of the ligamentum denticulatum, and it passes between the hypoglossal nerve and the first cervical nerve.

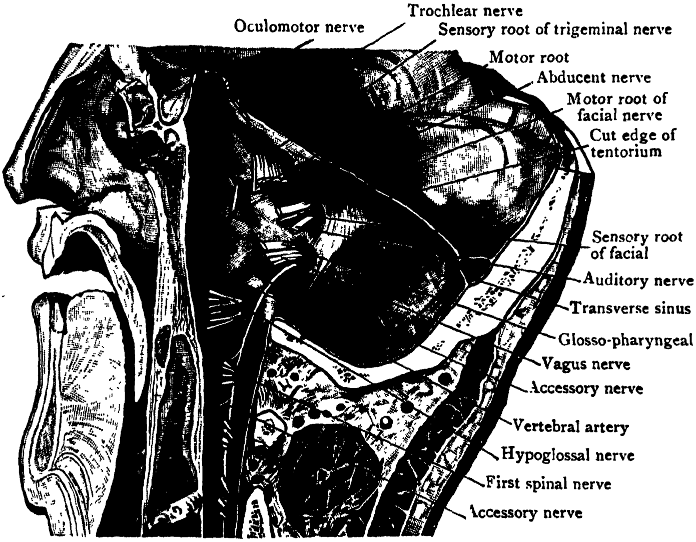


FIG. 44.—Section through the Head a little to the right of the median plane. It shows the posterior cranial fossa and the upper part of the vertebral canal after removal of the brain and spinal cord.

The *falx cerebelli* is a small fold of the dura mater pinched up, as it were, from the internal occipital crest. It fits into the posterior notch of the cerebellum; superiorly, it joins the tentorium; inferiorly it fades away near the foramen magnum.

Meningeal Vessels in Posterior Cranial Fossa.—Immediately before the vertebral artery pierces the dura mater, it gives off a *meningeal branch* which ramifies in the posterior cranial fossa and, if well injected, may be seen through the dura mater. The other *meningeal arteries* in the posterior fossa are small branches that descend into it from the posterior branch of the middle meningeal and small twigs from the occipital and ascending pharyngeal which enter through the jugular and mastoid foramina and the anterior condylar canal.

Dissection.—Slit up the falx cerebelli and look for a sinus —the *occipital*—sometimes contained within it. If the sinus is present, trace it to its two ends.

Lay open the *sigmoid sinus* by entering the knife at the anterior end of the transverse sinus, and running it down to the base of the skull, and then forwards to the jugular foramen. Look for the mouth of the *mastoid emissary vein* in the posterior wall of the sigmoid sinus about half-way down.

Remove the dura mater that overlies the jugular foramen, but do not injure the nerves that pierce it there. Then, find the end of the *inferior petrosal sinus* at the anterior end of the jugular foramen, and lay the sinus open by cutting through the dura mater that overlies the groove between the petrous temporal and the basi-occiput. Find the mouths of one or more of the *basilar sinuses* in the medial wall of the petrosal sinus, and trace them across to the sinus of the opposite side, taking care not to injure the abducent nerve.

Seize the *abducent nerve* of one side, pull on it gently, and trace it up to the apex of the petrous temporal by slitting through the inner layer of the dura mater.

Incise the inner layer of the *dura mater* in front of the foramen magnum, and strip it off—pulling it towards the jugular foramen and towards the foramen magnum. Then, incise the outer layer, and try to strip it off in the same way, and note what happens at the foramen.

Dura Mater of Base of Skull.—In contrast with the dura mater of the vault, the dura mater of the floor of the cranial cavity is firmly attached not only at the suture-lines but also between them. The outer layer is continuous, round the lips of each foramen, with the periosteum on the outer surface of the skull. At the foramen magnum, the inner layer is continuous with the spinal dura mater; and, at the lesser foramina that transmit nerves, it gives sheaths to the nerves.

VENOUS SINUSES IN POSTERIOR CRANIAL FOSSA.—The sinuses found in the posterior fossa are the sigmoid, the occipital, the inferior petrosal, and the basilar plexus of sinuses. The widest of them is the sigmoid.

Sigmoid Sinus.—This sinus receives its name from the S-shaped bend which it makes. It is the continuation of the transverse sinus, and is therefore an important sinus.

Origin, Course and Termination.—It begins in the attached margin of the tentorium immediately behind the base of the petrous temporal bone, and, curving downwards, it leaves the tentorium at once, and runs its course between the two layers of the dura mater of the posterior cranial fossa —first descending to the base of the skull, and then curving forwards to end at the jugular foramen, where it becomes the internal jugular vein.

Relations.—The sinus is closely related to the cerebellum throughout. As it descends, it grooves both the mastoid temporal and the petrous temporal, and is opposite the back of the root of the auricle. In this part of its course it is related *laterally* to the mastoid air-cells, and, outside the skull, to the posterior auricular vessels and nerve; while *anteriorly* there are :—(1) a small but important cavity in the

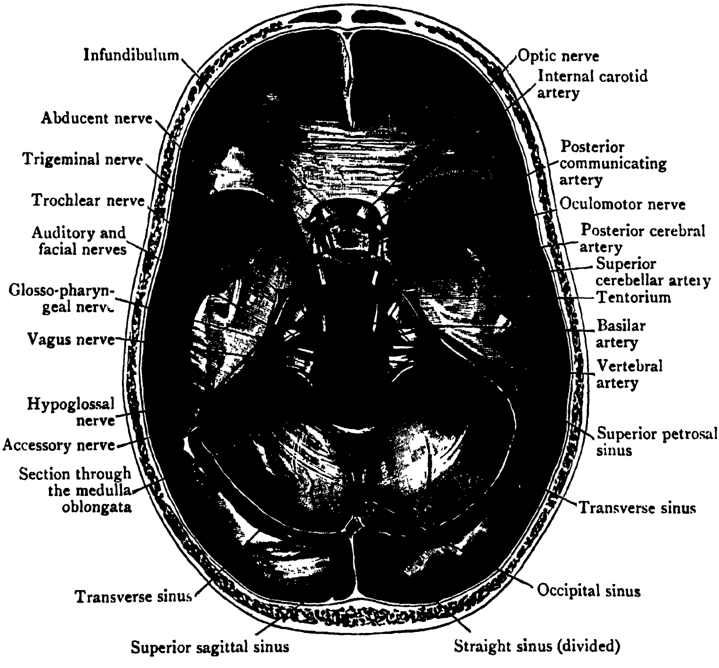


FIG. 45.—Floor of Cranial Cavity after removal of Brain and Tentorium Cerebelli. The blood-vessels which form the Circulus Arteriosus have been left in place.

temporal bone, called the tympanic antrum, which may be a very close relation if the sinus grooves the petrous temporal deeply, and (2), lower down, the vertical part of the facial nerve in its bony canal.

Tributaries and Connexions.—The sigmoid sinus receives the *posterior temporal diploic vein.* It is connected by the *mastoid emissary vein* with the occipital veins, by the *posterior condylar emissary vein* with the suboccipital plexus, and by the *occipital sinus* with the beginning of the transverse sinus. The mastoid emissary vein passes through the mastoid foramen and joins its descending part. The posterior condylar emissary vein, when present, joins it near its termination.

Occipital Sinus.—The occipital sinus is long, narrow, and not always present. One end joins the beginning of the transverse sinus at the internal occipital protuberance. From there, it first descends in the falx cerebelli, and then curves round the margin of the foramen magnum to join the sigmoid sinus near its termination. It may be united with its fellow in the falx, forming a single sinus there.

Inferior Petrosal Sinus.—This sinus is shorter but wider than the superior petrosal. It begins (like the superior petrosal) in the posterior end of the cavernous sinus; runs in the groove between the basi-occiput and the petrous temporal to the anterior part of the jugular foramen; and ends by joining the commencement of the internal jugular vein. It receives the internal auditory vein and veins from the cerebellum.

Basilar Plexus of Sinuses.—This is a network of sinuses in the dura mater on the clivus of the skull; on each side, they communicate with the inferior petrosal sinus.

Diploic Veins.—The wide venous spaces in the diploë of the flat bones of the skull are known as *diploic veins.* The spaces are lined with endothelium and communicate freely with one another. Some of them were cut when the skull-cap was removed, but they cannot be displayed except by a special dissection involving the removal of the outer table of the skull. At various points, they communicate with the meningeal veins, the venous sinuses and the veins outside the skull.

Four of the diploic veins have been named: (1) The *frontal*, which communicates with the supra-orbital vein through a minute aperture in the floor of the supra-orbital notch. (2) The *anterior temporal*, which communicates with the spheno-parietal sinus and the anterior deep temporal vein. (3) The *posterior temporal*, which communicates with the sigmoid sinus or the mastoid emissary vein. (4) The *occipital*, which communicates with the transverse sinus and the occipital veins.

The student should now review the venous sinuses, the veins and the meningeal vessels.

Venous Sinuses.—The venous sinuses are spaces between the layers of the dura mater. They are filled with venous blood into which cerebro-spinal fluid is drained from the subarachnoid space through the arachnoid villi and granulations. They receive veins from the brain; they communicate with the meningeal and diploic veins and with the veins outside the skull; and the largest of them—the sigmoid sinuses—end in the internal jugular veins. Seven of them are paired and five are unpaired.

The unpaired sinuses are:—(1) The *superior sagittal*, in the upper margin of the falx cerebri. (2) The *inferior sagittal*, in the free margin of the falx. (3) The *straight*, in the junction of the falx and tentorium. (4) Several small *intercavernous*, in the anterior and posterior margins of the diaphragma sellæ and in the floor of the hypophyseal fossa. (5) The *basilar*, in a network on the clivus of the skull.

The paired sinuses are:—(1) The *spheno-parietal*, on the posterior border of the lesser wing of the sphenoid. (2) The *cavernous*, on the side of the body of the sphenoid. (3) The *superior petrosal*, on the upper border of the petrous temporal. (4) The *inferior petrosal*, between the petrous temporal and basi-occiput. (5) The *occipital*, in the falx cerebelli and at the side of the foramen magnum. (6) The *transverse*, in the attached margin of the tentorium from the occipital protuberance to the base of the petrous temporal. (7) The *sigmoid*—the continuation of the transverse—on the side wall behind the petrous temporal and on the floor of the cranial cavity behind the petrous temporal and the jugular foramen.

The most important of the sinuses are the superior sagittal, the transverse, the sigmoid and the cavernous; and they should be thoroughly revised (pp. 96, 106, 116, 124).

Emissary Veins.—This name is given to the veins that pass through foramina in the cranial wall and connect the superior sagittal, the sigmoid and the cavernous sinuses with the veins outside the skull. The blood may flow in either direction in them, and they thus serve to equalise the venous pressure in the sinuses and the veins outside. The parietal and mastoid emissary veins are of surgical importance because infection from festering scalp-wounds may pass along them and attack the superior sagittal and sigmoid sinuses.

The emissary veins have all been mentioned already: (1) The *parietal* passes through the parietal foramen in the top of the skull and connects the occipital veins with the superior sagittal sinus. (2) Occasionally the vein that passes through the foramen cæcum and connects the beginning of the superior sagittal sinus with the veins of the frontal air-sinus, communicates also with the veins of the exterior and interior of the nose. (3) The *mastoid* passes through the mastoid foramen, behind the auricle, and connects the sigmoid sinus with the occipital veins or with the posterior auricular vein. (4) The *posterior condylar* passes through the hole behind the occipital condyle and connects the sigmoid sinus with the veins in the suboccipital triangle. (5) A plexus of veins traverses the carotid canal and connects the cavernous sinus with the pharyngeal veins. (6) A vein passes through the foramen ovale, or through the emissary sphenoidal foramen (Vesalius) when it is present, and connects the cavernous sinus with the plexus around the lateral pterygoid muscle. (7) The ophthalmic veins, in a sense, are emissary veins. In ordinary circumstances, blood flows backwards in them to the cavernous sinus; but it can flow in the opposite direction, and pass by the tributaries and communications of the ophthalmic veins to the veins of the face and infratemporal fossa.

Meningeal Vessels.—The *meningeal arteries* ramify in the outer layer of the dura mater; and their blood is distributed chiefly to the overlying bone, for the dura mater requires but little blood. They may be grouped according to the fossæ in which they lie.

In the anterior fossa, the meningeal arteries are small branches of the anterior and posterior ethmoidal arteries and of the middle meningeal.

In the middle fossa, the only one of any size is the middle meningeal. The others are the accessory meningeal, and small branches from the ophthalmic, the lacrimal and the ascending pharyngeal.

In the posterior fossa, they are all small. They come from the vertebral, the occipital and the ascending pharyngeal.

The *meningeal veins* are very thin-walled, and it is difficult to isolate them by dissection. They lie in the dura mater between the arteries and the bone. Some of them end in the venous sinuses, while others pass through the foramina alongside the arteries and end in veins outside the skull. They communicate with the diploic veins; and the larger ones—the middle meningeal—receive small tributaries from the brain as well as from the bone and the dura mater.

When the inspection of the interior of the cranium is completed, the dissectors will trace the nerves found in the cavernous sinus forwards into the orbit, and will display the other contents of the orbit. As the ethmoidal air-sinuses adjoin the orbit, it is convenient to expose and examine them at the same time.

THE ORBIT

Within the cavity of the orbit the following structures are grouped around the eyeball and the optic nerve :—

Muscles	Rectus superior.	Obliquus superior.
	Rectus inferior.	Obliquus inferior.
	Rectus lateralis.	
	Rectus medialis.	Levator palpebræ superioris.
Vessels	Ophthalmic artery and its branches.	
	Ophthalmic veins (superior and inferior), with their tributaries.	
Nerves	Oculomotor (3rd cranial).	
	Trochlear (4th cranial).	
	Abducent (6th cranial).	
	Frontal, Lacrimal, Naso-ciliary,	from ophthalmic division of the trigeminal or fifth cranial nerve.
	Zygomatic, Infra-orbital,	from maxillary division of trigeminal nerve.
	Ciliary ganglion.	Lacrimal gland.
	Fascial sheath of eyeball.	

***Dissection.*—With the aid of saw, chisel, and bone-forceps, remove the roof of the orbit and also the thick cranial wall above the orbital opening—leaving only the thin portion that bounds the opening.**

Begin by stripping the soft structures (including the periosteum) downwards from the cut margin of the skull to the superior orbital margin. Make two saw-cuts through the frontal bone down to the floor of the anterior fossa—one, vertically downwards opposite the cribriform plate of the ethmoid, and the second downwards and medially immediately in front of the lateral end of the lesser wing of the sphenoid.

With bone forceps chip away the bone between the saw-cuts down to the level of the floor of the anterior fossa. Next, take the chisel and cut through the bone immediately in front of the posterior border of the lesser wing of the sphenoid. Carry the cut medially to a point about a quarter of an inch in front of the optic foramen, and then forwards along the medial border of the orbital plate of the frontal bone. Now, with chisel and

bone-forceps, gradually chip away the roof of the ethmoidal sinuses and the bony roof of the orbit ; while doing so, be careful not to injure the *anterior ethmoid nerve*, which runs medially in a canal in the bony roof of the sinuses (Fig. 55) ; and do not injure the periosteum of the orbit, but remove the mucous lining of the roof of some of the ethmoidal sinuses.

Next, remove the remains of the lesser wing, with the exception of the margin of the optic foramen. The superior orbital fissure is now opened up, and no difficulty will be met with as the nerves in the wall of the cavernous sinus are traced forwards into the orbit, but the anterior clinoid process may be chipped away to gain additional freedom for further dissection.

Examine first the ethmoidal sinuses and then the periosteum of the orbit.

Ethmoidal Sinuses.—These are the small and very thin-walled cavities that occupy the whole of the labyrinth of the ethmoid bone, and are placed therefore between the orbit and the upper part of the cavity of the nose (Fig. 47). They are divided into three groups, of which the *anterior* and *middle* open into the middle meatus of the nose, and the *posterior* into the superior meatus. Explore them with a blunt probe (but do so gently, for their walls are very fragile) and seek to find the opening into the superior meatus.

Orbital Periosteum.—If the dissection has been successfully carried out, the periosteum that clothes the under surface of the orbital roof will be exposed uninjured. The periosteum of the orbit forms a funnel-shaped sheath which encloses all the contents of the cavity except the zygomatic nerve and the infra-orbital nerve and vessels. It is but loosely attached to its bony walls. It is directly continuous posteriorly, through the superior orbital fissure and the optic foramen, with the outer layer of the dura mater, and anteriorly, around the orbital opening, with the periosteum which clothes the exterior of the skull. It has important connexions with the palpebral fascia also.

***Dissection.*—Open the eyelids and draw the eyeball forwards with the forceps ; then, with a fine needle, carry a piece of thread through the ocular conjunctiva, being careful not to penetrate the eyeball, for that would make its subsequent inflation impossible. Finally, stitch the thread to the nose, and the eyeball will be securely held forwards. Turn now to the periosteum of the roof ; divide it transversely close to the anterior margin of the orbit, and then, from before backwards, along the middle line of the orbit. Turn the two flaps aside.**

As the superior orbital fissure is approached, be careful not to injure the nerves which pass through the fissure ; the one

most likely to be injured is the *trochlear nerve*, which lies near the medial end of the fissure. Secure it at once, and trace it forwards to the *superior oblique muscle*, which lies along the upper part of the medial wall of the orbit. In the middle line of the orbit, the *frontal nerve* will be found lying on the surface of the *levator palpebræ superioris*. Trace the nerve forwards to its division into the *supra-orbital* and *supratrochlear nerves*—each accompanied by an artery. Follow the supratrochlear nerve to the medial angle of the orbit, where it passes above the *pulley* of the superior oblique muscle.

Now, clean the superior oblique muscle from behind forwards. It ends in a tendon which passes forwards through a pulley at the upper and medial angle of the orbit, then turns backwards and laterally, and disappears below the levator palpebræ superioris and the superior rectus. Define both the tendon and the pulley.

Next, clean the *levator palpebræ superioris*, and note that it lies on the *superior rectus* muscle. Raise the levator palpebræ carefully, and secure a branch of the oculomotor nerve which pierces the superior rectus and enters the levator palpebræ.

Now, find the *lacrimal nerve* and *artery*, which lie in the fat at the junction of the roof with the lateral wall of the orbit ; trace them forwards to the *lacrimal gland*, and define it.

When all these structures have been found and cleaned, study them in detail.

Frontal Nerve.—The frontal nerve is the continuation of the stem of the ophthalmic nerve after it has given off its lacrimal and naso-ciliary branches. It enters the orbit through the superior orbital fissure, above the muscles, and runs forwards upon the upper surface of the levator palpebræ superioris immediately below the periosteum, and ends at a variable point by dividing into the supra-orbital and supratrochlear branches.

The *supratrochlear nerve* is the medial and smaller of the two. It runs towards the pulley or trochlea of the superior oblique muscle, above which it pierces the palpebral fascia, leaves the orbit, and turns upwards into the forehead. Its further course has been described already (p. 16). In the orbit, it gives off one small twig which arises close to the trochlea and descends to join the infratrochlear nerve.

The *supra-orbital nerve* is continued onwards in the line of the parent stem, and, after passing through the supra-orbital notch or foramen, it turns upwards into the forehead (p. 17). The division of the nerve into two branches was seen during the dissection of the scalp. Sometimes the separation takes place within the orbit, and then the *lateral* part (which is the larger) occupies the supra-orbital notch.

Lacrimal Nerve.—The lacrimal nerve is the smallest of the three branches of the ophthalmic. It enters the orbit through the superior orbital fissure, above the muscles, and runs forwards along the lateral wall of the cavity, above the lateral rectus muscle. At the anterior part of the orbit it gives numerous twigs to the lacrimal gland and sends a palpebral branch below the gland to the lateral part of the upper eyelid; and it receives a filament from the zygomatic nerve through which secretory fibres reach the lacrimal gland.

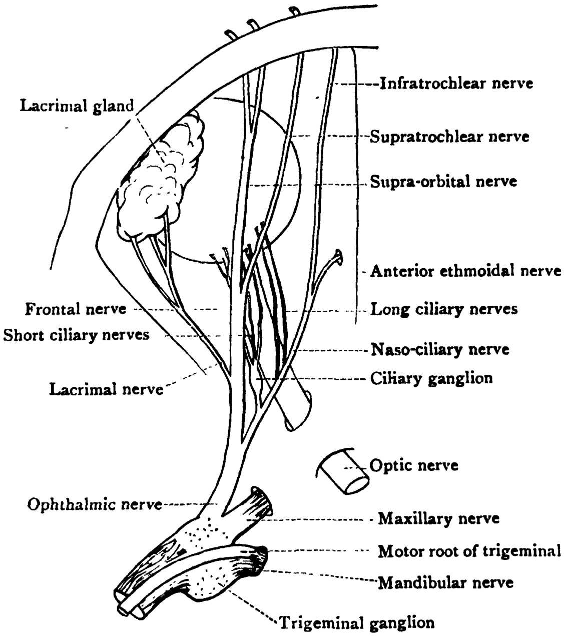


FIG. 46.—Ophthalmic Nerve of the Left Side. The Trigeminal Nerve and Ganglion have been turned over to show the motor root.

Trochlear Nerve.—The trochlear nerve is destined entirely for the supply of the superior oblique muscle. Having entered the orbit through the superior orbital fissure, above the muscles, it passes forwards and medially, and soon sinks into the superior oblique muscle.

Lacrimal Gland (Figs. 46, 47, 103).—The lacrimal gland is a lobular structure, about the size and shape of a bean, placed far forwards in the lateral part of the orbit close to the roof, in the hollow on the medial side of the zygomatic process of the frontal bone; and it is bound to the orbital margin by short fibrous bands. The deep or medial surface is slightly concave, and rests upon the levator palpebræ superioris and lateral rectus, which intervene between it and the eyeball. A portion of the gland, called its *palpebral*

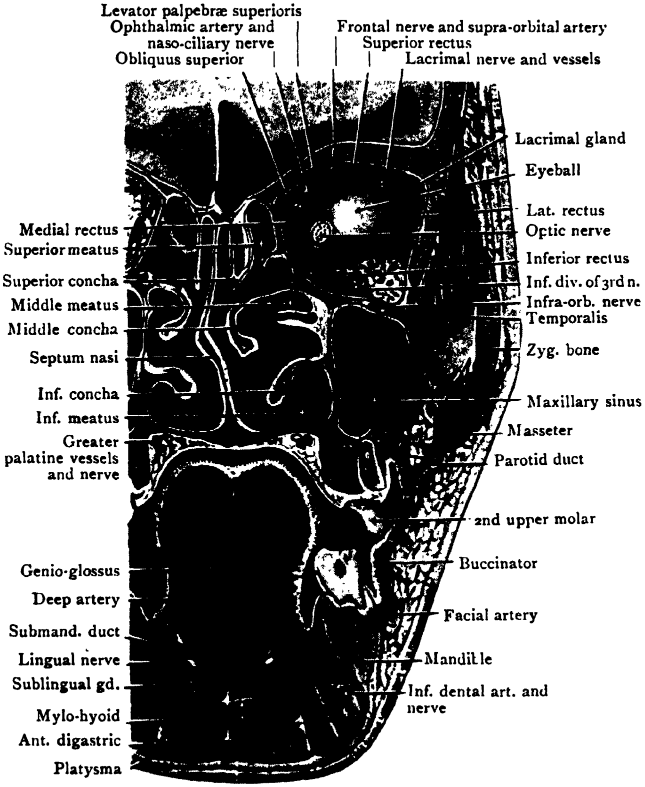


FIG. 47.—Coronal Section of Orbit, Nose, and Mouth.

process, projects down into the upper lid between the palpebral fascia and the conjunctiva (p. 39).

Nine or ten slender **ducts** proceed from the gland and its palpebral process, and open upon the deep surface of the upper eyelid in the neighbourhood of the fornix (Fig. 12).

The secretory nerves of the gland are derived from the spheno-palatine ganglion (1) through its orbital branches (p. 306) and (2) more deviously through the filament to the lacrimal nerve from the zygomatic nerve.

Levator Palpebræ Superioris.—The elevator muscle of the upper eyelid rests on the rectus superior. It arises from the roof of the orbit immediately in front of the optic foramen. In the anterior part of the orbit, it widens out into a broad, membranous expansion which is inserted into the upper eyelid (p. 38).

It is supplied by the upper division of the oculomotor nerve, and it is the elevator not only of the upper eyelid but also of the upper fornix of the conjunctiva.

> ***Dissection.***—**Divide the frontal nerve and the levator palpebræ superioris, and throw the ends forwards and backwards.**
>
> **Inflate the eyeball with a blow-pipe inserted through an oblique valvular aperture made with the point of a narrow-bladed knife ; on withdrawal of the pipe after inflation, the valvular character of the opening is sufficient to prevent the escape of the air.**
>
> **Behind the eyeball, at the sides of the superior rectus, the dissector will notice a quantity of loose bursal-like tissue. It is the *fascial sheath of the eyeball.* Seize the upper part of it with the forceps, and remove a small portion with a pair of scissors. Insert the handle of the knife into the space between it and the eyeball, and gauge the extent of the sheath, and try to make out the prolongations which it gives to the tendons of the muscles.**
>
> **Clean the *superior rectus* muscle from end to end, taking care of the upper division of the oculomotor nerve, which pierces it.**

Rectus Superior.—The superior rectus lies below the levator palpebræ superioris. It arises from the upper margin of the optic foramen, passes forwards above the optic nerve, and ends in a delicate and slightly expanded tendon which is inserted into the sclera about 8 mm. behind the sclero-corneal junction. It is supplied by a branch from the *superior division* of the *oculomotor nerve.* When it contracts it turns the eyeball so that the centre of the cornea moves upwards and medially.

Obliquus Superior.—The superior oblique muscle arises from the roof of the orbit immediately in front of the upper and medial part of the optic foramen, and passes forwards along the upper part of the medial wall of the cavity above the medial rectus. At the anterior part of the orbit it ends in a slender tendon which passes forwards through the *trochlea* and at once changes its direction—proceeding backwards and laterally above the eyeball under cover of the superior rectus. Beyond the lateral edge of the superior rectus the tendon expands slightly, and is inserted into the sclera midway between the entrance of the optic nerve and the cornea (Fig. 48).

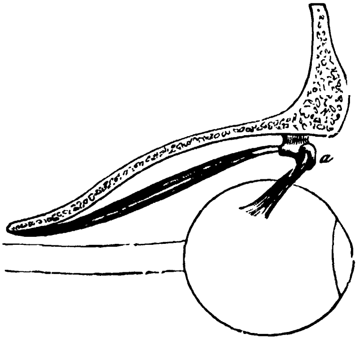


FIG. 48.—Diagram of the Superior Oblique Muscle. (From Hermann Meyer.)

a. Trochlea and synovial sheath.

The *trochlea* or *pulley* is a small fibro-cartilaginous ring attached by fibrous tissue to the trochlear fossa of the frontal bone. The pulley is lined with a synovial sheath which facilitates the movement of the tendon; and from its lateral margin it gives a fibrous investment to the tendon.

The superior oblique is supplied by the trochlear nerve; and it moves the eyeball so that the centre of the cornea is turned downwards and laterally.

Dissection.—**Divide the superior rectus at its middle and reflect it. The removal of some fat will bring the *optic nerve* more fully into view. At the posterior part of the orbit three structures will be seen crossing the optic nerve—viz., (1) the *naso-ciliary nerve*; (2) the *ophthalmic artery*; and (3) the *superior ophthalmic vein*. Clean them carefully and trace their branches. From the naso-ciliary nerve two thread-like branches —the *long ciliary nerves*—pass along the optic nerve to reach the eyeball. The *short ciliary nerves*—much more numerous— accompany the long ciliary branches, and can be disengaged from the fat around the optic nerve. Select a strong member of the short ciliary group and follow it backwards; it will lead you to the *ciliary ganglion*—a minute body situated on the lateral side of the optic nerve. With a little patience and care, the communicating branches which the naso-ciliary nerve and inferior division of the oculomotor nerve give to the ciliary ganglion can be isolated, and perhaps even the sympathetic branch from the internal carotid plexus will be found.**

Clear away the fat which lies lateral to the ganglion, and

secure the *abducent nerve*, which enters the lateral rectus. Lastly, clean the optic nerve.

Optic Nerve.—The optic nerve enters the orbit through the optic foramen. It carries with it a strong, loose sheath of dura mater, and delicate investments from the arachnoid and pia mater. The ophthalmic artery, which accompanies it, lies on its infero-lateral aspect. Within the orbit, the nerve inclines forwards and laterally and slightly downwards to reach the eyeball, where it pierces the sclera a short distance to the medial side of the centre of its posterior surface. The dissectors have noted already that the ophthalmic artery and vein and the naso-ciliary nerve cross above the optic nerve, and that the ciliary nerves and vessels surround it near the eyeball. The optic nerve is slightly longer than the distance which it has to run, in order that the movements of the eyeball may not be interfered with. Within the eyeball the optic nerve spreads out in the retina.

Naso-Ciliary Nerve.—The naso-ciliary nerve arises from the ophthalmic nerve in the anterior part of the cavernous sinus. It passes through the superior orbital fissure and enters the orbit between the two heads of the lateral rectus muscle. It then runs forwards and medially above the optic nerve to reach the medial wall of the orbit, where it runs forwards between the medial rectus and superior oblique muscles; and it divides into two terminal branches—viz., the infratrochlear and the anterior ethmoidal nerves. In addition to those, it gives off the following branches:—(1) a branch to the ciliary ganglion; (2) two long ciliary nerves; (3) the posterior ethmoidal nerve.

The *communicating branch to the ciliary ganglion* is a very slender filament which arises as the naso-ciliary enters the orbit. It runs along the lateral side of the optic nerve to reach the ciliary ganglion.

The two *long ciliary nerves* spring from the naso-ciliary as it crosses the optic nerve. They pass forwards to pierce the sclera near the medial side of the optic nerve. Their fibres are mainly sensory to the eyeball, but they contain also some sympathetic fibres which supply the dilator pupillæ muscle; these fibres arise in the superior cervical ganglion and reach the orbit *via* the internal carotid plexus and its branches to the ophthalmic nerve (p. 114).

The *posterior ethmoidal nerve* arises near the medial wall of the orbit, passes through the posterior ethmoidal foramen, and ends in branches to the mucous lining of the ethmoidal and sphenoidal sinuses.

Infratrochlear Nerve.—This is the smaller of the two terminal branches of the naso-ciliary nerve. It runs forwards along the medial wall of the orbit below the superior oblique muscle. After passing under the trochlea of that muscle, it emerges from the orbit and appears on the face above the medial angle of the eye, and supplies skin of the eyelids and of the upper half of the external nose (p. 30). Near the pulley it receives a communicating twig from the supratrochlear nerve.

Anterior Ethmoidal Nerve.—The anterior ethmoidal is larger than the infratrochlear, and runs a more devious course. It leaves the orbit by the anterior ethmoidal canal, which conducts it to the interior of the cranium, where it appears at the lateral margin of the cribriform plate of the ethmoid; the canal is in the roof of the ethmoidal sinuses (Fig. 55), and was probably opened when the roof was removed. On the cribriform plate the nerve turns forwards under the dura mater, and almost immediately disappears, through a slit-like aperture at the side of the crista galli, into the nasal cavity. There, it gives *internal branches* to the mucous membrane, and is continued downwards between the mucous membrane and the nasal bone. Finally, it emerges on the face, as the *external nasal nerve*, by passing between the lower margin of the nasal bone and the upper cartilage of the nose, and supplies skin on the lower half of the nose (p. 30).

Ciliary Ganglion (Fig. 52).—The ciliary ganglion is no bigger than the head of a large pin, and lies in the posterior part of the orbit, on the lateral side of the optic nerve. It receives three roots or communicating branches; and it gives off the short ciliary nerves.

The *sensory root* is the long, slender filament given to it by the naso-ciliary nerve. The *motor (parasympathetic) root* is a short, stout twig which springs from the branch of the oculomotor nerve to the inferior oblique muscle. The *sympathetic root* is a filament that arises in the cavernous sinus from the plexus around the internal carotid artery and accompanies the naso-ciliary nerve and its branch to the ganglion. The sensory and sympathetic fibres pass without interruption into the short ciliary nerves; but the motor (parasympathetic) fibres are relayed in the ganglion, and the new fibres that arise in the ganglion are carried by the short ciliary nerves into the eyeball to supply the sphincter muscle of the pupil and the ciliary muscle.

The *short ciliary nerves*—about half a dozen—pass along the optic nerve and divide until, at the back of the eyeball, from twelve to twenty may be counted. They pierce the sclera around the entrance of the optic nerve (p. 369).

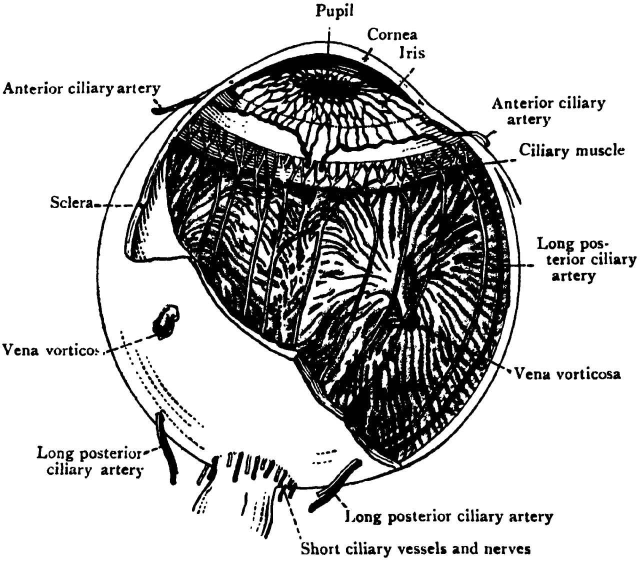

Pupil
Cornea
Iris
Anterior ciliary artery
Anterior ciliary artery
Ciliary muscle
Sclera
Long posterior ciliary artery
Vena vorticosa
Vena vorticosa
Long posterior ciliary artery
Long posterior ciliary artery
Short ciliary vessels and nerves

FIG. 49.—Dissection of Eyeball showing the Vascular Coat and arrangement of Ciliary Nerves and Vessels.

The four small ganglia associated with branches of the trigeminal nerve—namely, the *ciliary*, *spheno-palatine*, *otic* and *submandibular*—belong to the parasympathetic division of the autonomic nervous system. If the students have not already acquired a general idea of that system, they should consult a text-book of Anatomy, in order that they may appreciate the meaning of the connexions and functions of these ganglia. Short explanatory paragraphs on the autonomic nervous system will be found in Vol. II. of this Manual.

Ophthalmic Artery.—The ophthalmic artery is a branch of the internal carotid artery, and arises as soon as the internal carotid has left the cavernous sinus and pierced the arachnoid mater.

Course and Relations.—The artery passes through the optic foramen within the arachnoid sheath of the optic nerve and enters the orbit. At first, it lies below the optic nerve, but, gradually piercing the arachnoid and dural sheaths of the nerve, the artery soon winds round its lateral side, and then crosses above it to reach the medial wall of the orbit.

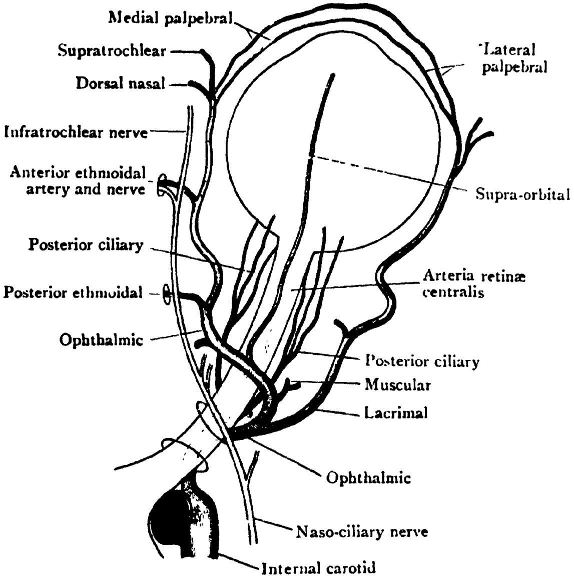


FIG. 50.—Diagram of the Ophthalmic Artery and its Branches. (After Quain and Meyer, modified.)

There, the artery runs forwards below the superior oblique muscle, and near the front of the orbit it ends by dividing into the *supratrochlear artery* and the *dorsal nasal artery*.

Branches.—The branches are very numerous, but it is seldom that they can all be satisfactorily displayed unless a special injection has been made. They are shown in Fig. 50. The largest is the *lacrimal*, which accompanies the lacrimal nerve. The most important is one of those which are given to the eyeball, namely, the *arteria retinæ centralis*, which, though so important, is very small. It enters the optic nerve in the optic foramen and runs in its substance to the retina; it is the *only artery of supply to the retina.*

Ophthalmic Veins.—As a general rule there are two ophthalmic veins—superior and inferior. The *superior ophthalmic vein* is the larger of the two and it accompanies the artery. It begins in the anterior part of the orbit, and communicates with the supra-orbital and supratrochlear veins. The *inferior ophthalmic vein* lies below the optic nerve, and communicates with the pterygoid venous plexus by an offset which passes through the inferior orbital fissure. The two ophthalmic veins receive numerous tributaries during their course through the orbit; finally, they pass between the two heads of the lateral rectus muscle, and through the superior orbital fissure, to open into the cavernous sinus, either separately or by a common trunk.

Origins of the Muscles that move the Eyeball.—Associated with the origins of the recti muscles there are two tendinous arches, a superior and an inferior. Both are attached laterally to a projection on the lower margin of the superior orbital fissure. The two bands diverge from each other as they pass medially across the superior orbital fissure; and they are attached to the upper and lower margins of the optic foramen, meeting each other again at its medial or anterior margin. The *superior*, *inferior* and *medial recti* arise from these bands above, below and at the medial side of the optic foramen, respectively. The *lateral rectus* arises by two closely-joined heads from the lateral parts of the two bands and the adjoining margins of the orbital fissure. The interval that separates these lateral parts and the heads of the rectus lateralis transmits the two divisions of the oculomotor nerve, the naso-ciliary nerve, the abducent nerve, and the ophthalmic veins.

The *superior oblique* springs from the body of the sphenoid between the superior and medial recti. The origin of the *inferior oblique* is entirely away from the other muscles. It arises from the floor of the orbit far forward at the medial side.

***Dissection.*—To display the attachments of the ocular muscles which arise at the apex of the orbit, divide the optic nerve close to the optic foramen, and turn the eyeball forwards. Then, define the origin of each muscle, but take care not to injure the structures which pass between the heads of the lateral rectus.**

Replace the eyeball in position and display the *inferior oblique*; it lies in the anterior part of the orbital cavity and is dissected best from the front. Evert the lower eyelid and make an incision through the inferior fornix of the conjunctiva. A little dissection and the removal of some fat will then expose the inferior oblique muscle.

After the origins of the muscles have been displayed, study first the arrangement of the nerves as they pass through the superior orbital fissure, next the insertions of the muscles which move the eyeball, and finally the remaining structures that lie within the periosteum of the orbit.

Position of Nerves in Superior Orbital Fissure.—Turn back to p. 114 and re-read the description of the nerves in the cavernous sinus. Identify them again and trace them forwards, noting that they undergo some alteration of relative positions as they approach and enter the orbit.

The *lacrimal*, *frontal*, and *trochlear nerves* enter the orbit above the lateral rectus muscle. The other nerves enter between the heads of the lateral rectus :—the superior division of the *oculomotor nerve* is the highest ; next comes the *naso-ciliary nerve* ; then the inferior division of the oculomotor nerve ; and the *abducent nerve* is the lowest.

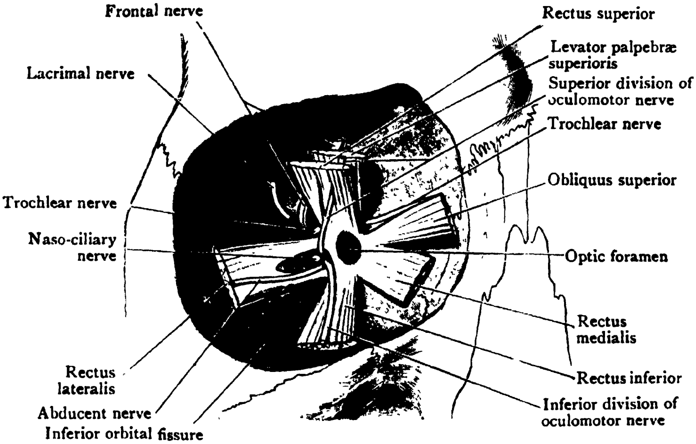


FIG. 51.—Diagram of Right Orbital Cavity, and of the Origin of the Ocular Muscles in relation to the optic foramen and the superior orbital fissure, and the nerves that traverse the fissure.

Insertions of the Muscles that move the Eyeball.—The recti are inserted into the sclera about a quarter of an inch behind the cornea. The medial rectus has the most anterior insertion, and both the *medial* and the *lateral rectus* are attached a little farther forwards than the *superior* and *inferior recti*. The insertions of the *oblique muscles* are both much farther back than the insertions of the recti—behind the equator of the eyeball, and mainly lateral to its sagittal meridian.

Oculomotor Nerve.—The two divisions of the oculomotor nerve enter the orbit through the superior orbital fissure, between the two heads of the lateral rectus. The *superior division* has been traced to the rectus superior and, through it, to the levator palpebræ superioris. The *inferior division* is larger. It divides into three branches which supply the rectus medialis, the rectus inferior and the obliquus inferior ; the nerves to the two recti enter their ocular surfaces ; the nerve to the inferior oblique runs forwards between the rectus inferior and rectus lateralis, and enters the posterior border of the inferior oblique muscle. Soon after its origin this branch gives the *parasympathetic* (*motor*) *root* to the ciliary ganglion.

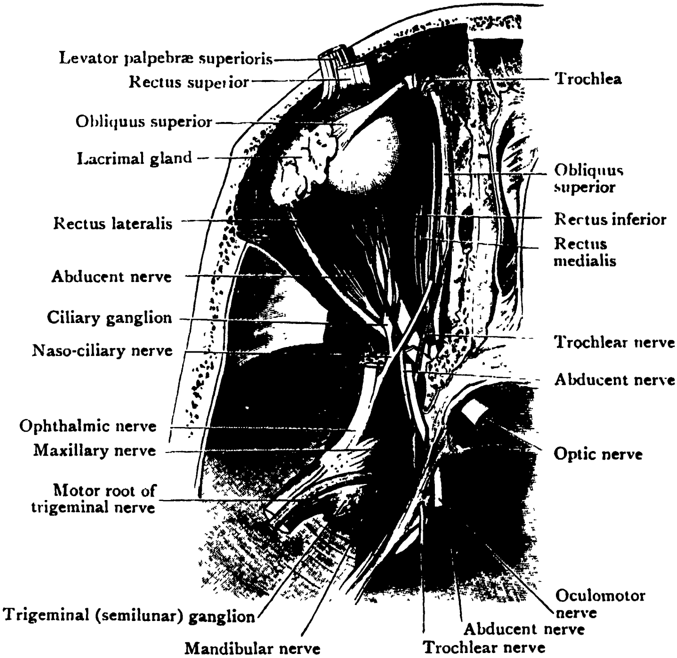


FIG. 52.—Dissection of Orbit and Middle Cranial Fossa. Both roots of the fifth nerve, with the trigeminal ganglion, are turned laterally.

Abducent Nerve.—The abducent nerve is closely applied to the ocular surface of the lateral rectus. It enters the orbit between the heads of that muscle, and supplies it only.

Obliquus Inferior.—The inferior oblique muscle arises from a small area on the floor of the orbit immediately lateral to the opening of the naso-lacrimal canal. It passes laterally below the inferior rectus muscle, and then upwards and slightly backwards (Fig. 103) to end in a membranous tendon which is inserted into the lateral side of the sclera under cover of the rectus lateralis. The insertion is not far from that of the superior oblique. The inferior oblique is supplied by the *inferior division* of the *oculomotor nerve*. It turns the eyeball so that the centre of the cornea is directed upwards and laterally:

Fascial Sheath of Eyeball (Fascia Bulbi).—The connexions of the sheath of the eyeball cannot be satisfactorily displayed, in every detail, in an ordinary dissection. The sheath may be studied from a threefold point of view:—(1) in its connexion with the eyeball; (2) in its connexions with the muscles inserted into the eyeball; and (3) in its connexions with the walls of the orbit.

The relation which the sheath bears to the eyeball is very simple. The membrane is spread over the posterior five-sixths of the globe—the cornea alone being free from it. Its internal surface is smooth, and is connected to the eyeball by some soft, yielding and humid areolar tissue—the interval between them being, in fact, an extensive lymph space. It is, therefore, a membranous socket in which the eyeball can rotate with the greatest freedom. *Anteriorly*, its external surface is firmly adherent to the ocular conjunctiva close to the margin of the cornea. *Posteriorly*, it is in contact with the fat, to which it is loosely adherent, and it fuses with the sheath of the optic nerve where the nerve pierces the sclera.

The tendons of the various ocular muscles are inserted into the eyeball within the fascial sheath, and they gain the interior of the sheath by piercing it opposite the equator of the globe (Fig. 53). The lips of the openings through which the recti muscles pass are prolonged backwards on the muscles like sleeves. These sheaths gradually become attenuated, until they blend with the epimysium of the muscular bellies. The sheath of the superior oblique muscle covers only the reflected portion of the tendon; and it ends by becoming attached to the trochlea. The sheath of the inferior oblique may be traced as far as the floor of the orbit. The ocular edge of each of the apertures through which the recti pass is strengthened by a slip of fibrous tissue (Lockwood); and, as the sheaths are firmly bound to the bony wall of the orbit at various points, these slips act as pulleys, and protect the eyeball from pressure during contraction of the muscles.

An admirable view of the relations which the sheath presents to the eyeball and the tendons of the ocular muscles can be obtained by the following dissection.

Dissection.—Separate the eyelids completely by incisions from the angles to the orbital margins. Pull the eyelids widely apart to expose as much as possible of the anterior face of the eyeball. Next, divide the conjunctiva by a circular incision immediately beyond the cornea ; the fascial sheath is divided at the same time. Now, raise both conjunctiva and sheath carefully from the surface of the eyeball, and spread them out round the orbital opening as depicted in Fig. 53. The openings in the sheath for the tendons and the thickened margins of the apertures are well seen.

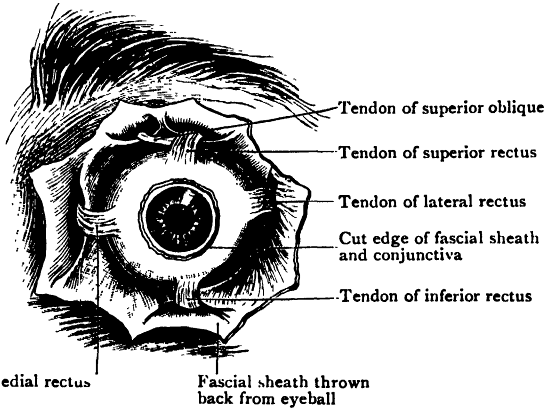

Tendon of superior oblique
Tendon of superior rectus
Tendon of lateral rectus
Cut edge of fascial sheath and conjunctiva
Tendon of inferior rectus
Tendon of medial rectus
Fascial sheath thrown back from eyeball

FIG. 53.—Dissection of Fascial Sheath of Eyeball from the front.

Check and Suspensory Ligaments.—The fascial sheath of the eyeball is connected with the walls of the orbit chiefly by the suspensory and check ligaments.

The *suspensory ligament* plays an important part in supporting the eyeball. It stretches across the anterior part of the orbit after the fashion of a hammock ; its two extremities are narrow, and are attached to the zygomatic and lacrimal bones. Below the eyeball it widens out and blends with the fascial sheath.

The *lateral* and *medial check ligaments* are strong bands which pass from the sheaths around the lateral and medial recti muscles to obtain attachment to the zygomatic and lacrimal bones near the extremities of the suspensory ligament. The check ligaments limit the contraction of the medial and lateral recti muscles, and thus prevent excessive rotation of the eyeball in a lateral or medial direction.

There is a similar but less direct provision by means of which the actions of the superior and inferior recti muscles are limited. The action of the superior rectus is checked through an intimate connexion with the levator palpebræ superioris in the anterior part of the orbit ; the action of the inferior rectus is checked through a connexion with the suspensory ligament.

PLATE V

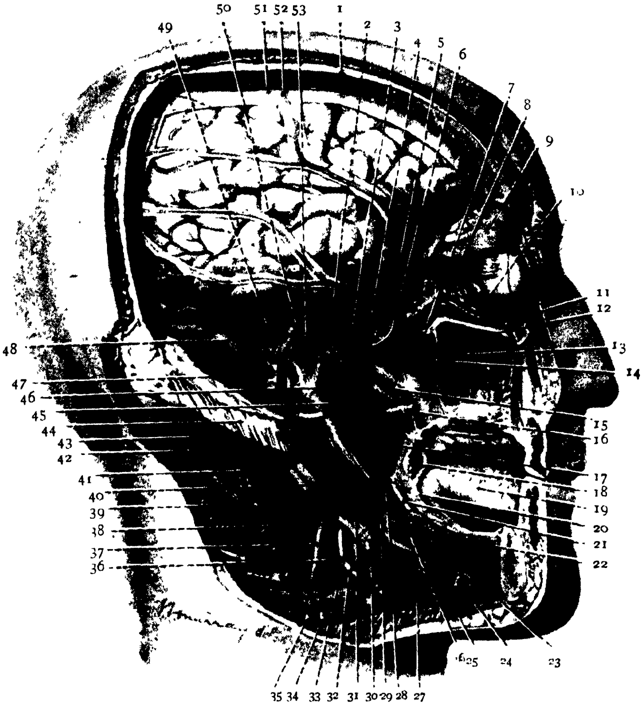


Fig. 54.—Dissection of the Head.

For enlargements of parts of this illustration, see Figs. 103, 104, 144.

1. Coronal suture.
2. Bony part of pharyngo-tympanic tube.
3. Middle meningeal artery.
4. Post. branch of middle meningeal artery.
5. Anterior branch.
6. Mandibular nerve.
7. Maxillary nerve.
8. Lateral rectus.
9. Lacrimal gland.
10. Inferior oblique.
11. Oculomotor nerve.
12. Maxillary artery.
13. Maxillary sinus.
14. Tensor palati.
15. Pharyngo-tympanic tube.
16. Tensor palati.
17. Superior constrictor.
18. Buccinator.
19. Tongue.
20. Cut edge of mucous membrane.
21. Lingual nerve.
22. Mylo-hyoid.
23. Digastric, anterior belly.
24. Facial artery.
25. Platysma.
26. Submandibular gland.
27. Anterior facial vein.
28. Ascending palatine artery.
29. Stylo-glossus.
30. Stylo-hyoid.
31. External carotid artery.
32. Hypoglossal nerve.
33. Sterno-mastoid artery.
34. External jugular vein.
35. Great auricular nerve.
36. Internal jugular vein.
37. Accessory nerve.
38. Levator scapulæ.
39. Splenius capitis.
40. Digastric, posterior belly.
41. Longissimus capitis.
42. Occipital artery.
43. Splenius capitis.
44. Sterno-mastoid.
45. Internal carotid artery.
46. Levator palati.
47. Facial nerve.
48. Sigmoid sinus.
49. Tympanic antrum.
50. Malleus and incus.
51. Dura mater.
52. Anterior br. of middle meningeal artery.
53. Tympanic membrane.

[*Facing p.* 144

PLATE VI

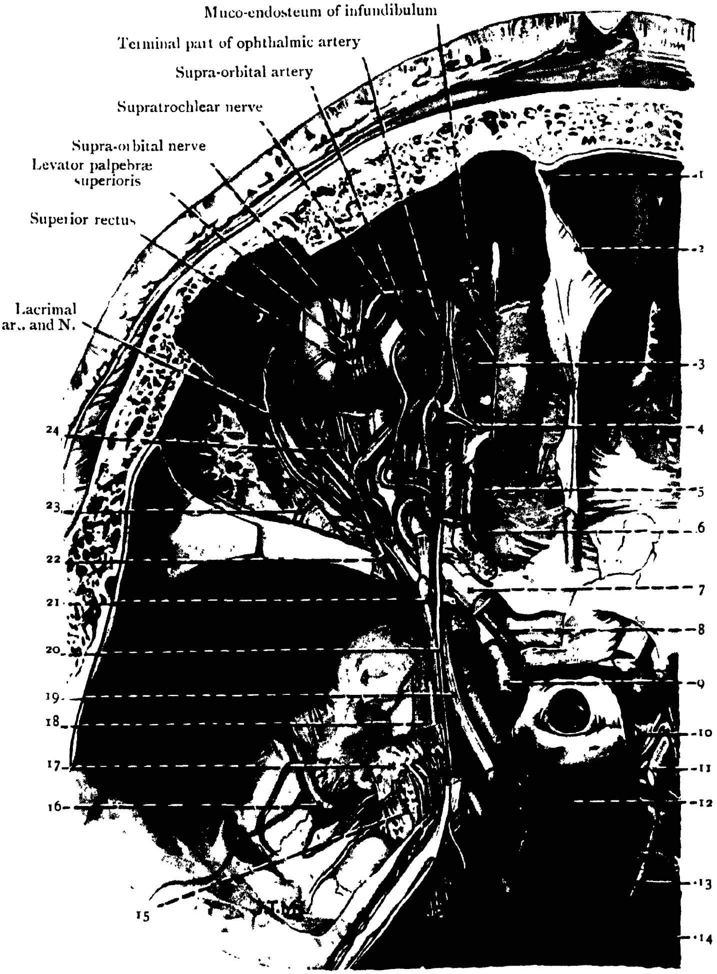


FIG. 55.—Dissection of Orbit and Middle Cranial Fossa.

1. Superior sagittal sinus.
2. Cut anterior part of falx cerebri.
3. Anterior ethmoidal air-sinus.
4. Anterior ethmoidal artery and nerve.
5. Middle ethmoidal air-sinus.
6. Posterior ethmoidal air-sinus.
7. Optic nerve.
8. Ophthalmic artery.
9. Internal carotid artery.
10. Wall of right cavernous sinus.
11. Oculomotor nerve.
12. Network of basilar sinuses.
13. Abducent nerve.
14. Inferior petrosal sinus.
15. Trigeminal ganglion.
16. Middle meningeal artery.
17. Mandibular nerve.
18. Maxillary nerve.
19. Oculomotor nerve.
20. Trochlear nerve.
21. Frontal nerve.
22. Superior ophthalmic vein.
23. Orbital branch of mid. meningeal art.
24. Post. ciliary arts. and short ciliary Ns.

The remaining contents of the orbit are outside the periosteum—the *zygomatic nerve* along its lateral wall and the *infra-orbital nerve* in its floor—and they are more conveniently dissected when the maxillary sinus and the terminal part of the maxillary nerve are examined. The dissectors will now leave the orbit and proceed to dissect the anterior part of the neck ; but, before they pass to the neck, they will fill the cranial cavity with tow steeped in preservative solution, replace the skull-cap and retain it in position by bringing the flaps of the scalp over it and stitching them together.

ANTERIOR PART OF THE NECK

After the skull-cap has been replaced and the scalp has been stitched over it, let the head hang down over the end of the table, pull the chin as far from the sternum as possible and fix it in position with hooks. Then, examine the front of the neck.

It is a large triangular area divided by the median plane into the *anterior triangles of the neck*, each of which is bounded above by the mandible, behind by the sterno-mastoid, and in front by the median line of the neck.

Surface Anatomy.—Pass the index finger from the chin to the sternum along the median line, and identify, in sequence, the body of the *hyoid bone*, the anterior border of the *thyroid cartilage*, the arch of the *cricoid cartilage* and the rings of the *trachea*. The tracheal rings are partly masked by the isthmus of the thyroid gland.

Grasp the *hyoid bone* between finger and thumb, and trace its *greater horns* backwards. Note that their tips are very close to the sterno-mastoids, which may overlap them. Trace the upper border of the thyroid cartilage backwards, and note that it ends in a projection—the *superior horn*—which points upwards, and is immediately in front of the sterno-mastoid.

Press the fingers along a line leading from the mastoid process towards the tip of the shoulder. The deep, bony resistance encountered is given by the *transverse processes* of the cervical vertebræ, of which the *first* is the one felt immediately below the mastoid process, while the *fourth* is at the level of the upper border of the thyroid cartilage, and the *sixth* is at the level of the arch of the cricoid cartilage.

The dissectors should make themselves thoroughly familiar with the landmarks mentioned above; and they should note, though in the dead subject there may be some difficulty in palpating the isthmus of the thyroid gland, which lies on the second, third and fourth rings of the trachea, that they will have no difficulty in locating the small, soft, cushion-like mass in the living body.

Dissection.—**The skin has already been cut along the lower border of the mandible and along the sterno-mastoid. Now, make a median incision through it, from the chin to the sternum, and reflect the flap from above downwards.**

The superficial fascia of the anterior triangle is now exposed, and fibres of the *platysma* are seen in its upper and posterior part. The lower part of the platysma has been reflected already; reflect now the rest of it, turning the muscle upwards and dividing the nerve-twigs that supply it. Secure the *cervical branch of the facial nerve* as it emerges from the lower end of the parotid gland, and trace it forwards. Secure, next, the two terminal branches of the *anterior cutaneous nerve of the neck* as they cross the sterno-mastoid about its middle, and trace them to their termination.

Find the *anterior jugular vein* near the median line, and trace it downwards to the point where it pierces the deep fascia—about an inch above the sternum; and then clean the deep fascia of the whole area of the anterior triangle.

Next, make a transverse incision through the first layer of the deep fascia immediately above the sternum, and a pair of incisions upwards for an inch and a half along the anterior borders of the two sterno-mastoids; reflect the flap of deep fascia upwards to expose the *suprasternal space* between the first and second layers of deep fascia; define and clean the contents of the space; follow the *anterior jugular vein* and the second layer of deep fascia laterally as far as you can under cover of the sterno-mastoid; and trace the fascia upwards also till it blends with the first layer—about midway between the sternum and the thyroid cartilage. Pass the handle of the knife downwards in front of the second layer, and ascertain its line of attachment to the back of the manubrium sterni.

Before proceeding farther with the dissection, study the structures that have been encountered.

Superficial Fascia.—The superficial fascia in this region varies in thickness with the amount of fat in it, and is most laden with fat below the chin. It is only loosely connected with the skin and the deep fascia; and the skin of the front of the neck can therefore be moved freely. Its contents are:—the *platysma*; the *cervical branch of the facial nerve*; the *anterior cutaneous nerve of the neck* (p. 48); small *unnamed arteries* derived from the deeper arteries; and the *anterior jugular vein* and a network of very slender veins whose blood is drained away by that vein and by the external jugular vein.

Platysma.—Parts of the platysma muscle have been dissected already—in the face and in the posterior triangle.

It is a long, wide, thin sheet of muscle that lies in the superficial fascia of the side and the front of the neck, and also in the upper part of the front of the chest and the lower part of the face. It is the most superficial structure in the superficial fascia. The external jugular vein and the cervical branch of the facial nerve are under cover of it, and the branches of the anterior cutaneous nerve and supraclavicular nerves have to pierce it to reach the skin. In the neck, it overlies the lower and anterior part of the posterior triangle and the upper part of the anterior triangle.

It arises, below the clavicle, from the fasciæ and skin over the pectoralis major and the deltoid. Its anterior part is inserted into the anterior part of the lower border of the mandible, the most anterior fibres decussating with their fellows of the other side for half an inch below the chin. The posterior part curves upwards over the mandible to be attached to the skin of the lower part of the face, mingling with the muscles of the lips, and helping to form the risorius.

It is supplied by the cervical branch of the facial nerve. It is the diminutive representative of the widespread muscular sheet that moves the skin in lower animals.

Cervical Branch of Facial Nerve.—This nerve emerges from the lower end of the parotid gland, pierces the deep fascia, sweeps forwards below the mandible, under cover of the platysma, communicates with the anterior cutaneous nerve, supplies the platysma, and sends a spray of fine branches upwards to help to supply the muscles of the lower lip.

Anterior Jugular Vein.—This is the smallest of the jugular veins, and varies in width inversely with the external jugular. It begins below the chin by the union of small, unnamed veins from the chin and the lower lip. It descends in the superficial fascia, half an inch or less from the median plane, receiving small tributaries from neighbouring parts. About an inch above the sternum, it pierces the first layer of deep fascia, and, bending abruptly, it runs laterally, immediately above the clavicle, deep to the sterno-mastoid, across the sterno-hyoid, sterno-thyroid and scalenus anterior muscles, and ends in the external jugular vein. At the point where it bends, it is connected with its fellow by a fairly wide, transverse channel, called the **jugular arch,** which lies in the suprasternal space and is an important anterior relation of the trachea.

The anterior jugular vein has no valves. It may be absent on one or other side ; and sometimes the right and left veins are united—forming a median vein.

Suprasternal Space.—This is the space between the first and second layers of deep fascia immediately above the sternum. It contains some fatty areolar tissue, the jugular arch, the interclavicular ligament, and, occasionally, a lymph gland.

The dissector will now clean and examine the sterno-mastoid muscle.

> ***Dissection.***—**Clean the suface of the sterno-mastoid, but preserve the external jugular vein and the nerves that lie on the muscle. Follow its posterior border up to the skull, cleaning the border and removing the fat and lymph-glands from under cover of it ; but avoid injury to the accessory nerve and the other nerves that emerge at its posterior border. The parotid gland overlaps the upper part of the muscle. Push the parotid forwards, and define the anterior border of the upper part of the muscle ; secure the *accessory nerve* and the artery that accompanies it as they enter the muscle. Then, clear away the fat from the deep surface of the sterno-mastoid, and trace it up to the skull. Lastly, evert the anterior border of the rest of the muscle, and clean the vessels that enter it. Do not be satisfied till the muscle is cleaned from end to end.**

Sterno-Cleido-Mastoid.—The sterno-mastoid is the most important muscle in the neck ; and it is the best landmark in the neck, for, when it turns the face towards the opposite side, it stands out as a well-defined, rounded ridge between the anterior and posterior triangles of the neck.

It arises by two heads—a sternal and a clavicular. The *sternal head* is rounded, pointed and chiefly tendinous. It springs from the upper part of the anterior surface of the manubrium sterni ; as it passes obliquely upwards, it widens rapidly, and it crosses the medial part of the sterno-clavicular joint. The *clavicular head*—wide, thin and fleshy, with a few tendinous bundles intermixed—springs from the upper surface of the medial third of the clavicle. A narrow interval, filled with fascia, separates the heads inferiorly ; at a higher level, the sternal portion overlaps the clavicular portion ; and half-way up the neck the two heads unite into a fleshy mass which ascends to be inserted into the mastoid temporal bone and the superior nuchal line. At the insertion, the anterior part is thick and tendinous and is attached to the front of the mastoid process; the rest of it is thin and aponeurotic and spreads out to be attached to the lateral surface of the mastoid temporal bone above the mastoid process and into the lateral half (or more) of the superior nuchal line. This part was probably detached when the back of the neck was dissected.

One branch of the occipital artery enters it with the accessory nerve ; another enters it a little lower down, opposite the angle of the mandible. The sterno-mastoid branch of the superior thyroid artery enters it at the level of the cricoid cartilage ; and a branch of the suprascapular enters it a little above the clavicle.

The muscle is supplied by the accessory nerve and the anterior primary ramus of the second cervical nerve.

Acting alone, the muscle bends the head to its own side and rotates the head so that the face is turned towards the other side. The two sterno-mastoids acting together bend the neck forwards ; but, since they are inserted behind the axes of the atlanto-occipital joints, they can tilt the head backwards.

The dissectors will now study the structures that lie in the anterior median line of the neck and alongside that line.

Median Region of Front of Neck.—This region includes the fasciæ, muscles and other structures found in the median strip, about an inch in width, between the chin and the sternum.

Superficial fascia.—This layer contains the vertical part of the *anterior jugular vein*—one on each side of the median plane. It is thickest below the chin. In this region, its superficial part contains the decussating fibres of the platysma muscles for half an inch below the chin ; and three or four small *submental lymph-glands* lie between it and the deep fascia. These glands receive the lymph from the chin, the lower lip and the tip of the tongue ; and, even when healthy, they can usually be felt in the living person as little nodules by the thumb pressed upwards behind the chin.

Deep fascia.—The investing layer of deep fascia is adherent to the hyoid bone. As it passes from the hyoid bone to the mandible it splits to cover both surfaces of the *anterior belly of the digastric* muscle, which passes downwards and laterally from the lower border of the mandible at the side of the symphysis, diverging from its fellow; and, as the fascia descends to the sternum, it splits to enclose the suprasternal space, which contains the *jugular arch* and the *interclavicular ligament*. In the lower half of the region, there are three layers of deep fascia—the two layers into which the investing fascia divides and a deeper layer called the *pretracheal fascia*, which is thinner and looser in texture. The pretracheal fascia is attached to the thyroid and cricoid cartilages and envelops the thyroid gland; from these connexions, it descends over the front and sides of the trachea into the thorax to end there by blending with the back of the upper part of the pericardium.

The dissectors of the two sides of the neck will now unite in removing the deep fascia and defining the structures that are under cover of it.

Dissection.—**Remove the deep fascia from the anterior belly of each digastric and from the area between them; look for the *submental lymph-glands* on the surface of the fascia, and note the connexions of the fascia. The muscular sheet exposed by its removal is part of the right and left *mylo-hyoid* muscles.**

Push aside the anterior jugular vein, and remove the deep fascia from the muscles that lie on each side of the median plane between the hyoid bone and the sternum. Then, carefully remove the areolar tissue and fat from the median strip that separates the muscles of the two sides to expose the *pretracheal fascia*, and note its connexions. Remove the pretracheal fascia from the trachea below the isthmus of the thyroid gland, cleaning and preserving the *inferior thyroid veins*, which run downwards from the isthmus. If a small artery is found ascending over the trachea to the isthmus, it is the occasional *thyroidea ima*.

Now, pass to the upper border of the isthmus, and look for a slender fibro-muscular band called the *levator glandulæ thyroideæ*. When present, it extends from the isthmus to the hyoid bone, and is usually on the left side of the median plane. Then, divide the pretracheal fascia along the upper border of the isthmus, clean the isthmus and the vessels on its surface, and note that now, when the pretracheal fascia is divided above it, the isthmus can be pulled downwards. Next, detach the pretracheal fascia from the cricoid and thyroid cartilages, and expose and clean the *crico-thyroid ligament* in the median plane, the anastomosis of the *crico-thyroid arteries* on the surface of the

ligament, and a small muscle—the *crico-thyroid muscle*—on each side.

Lastly, clean the median *thyro-hyoid ligament* and the anastomosis of *infrahyoid arteries* on its surface ; and look for the small *hyoid bursa*, tucked in between the ligament and the back of the body of the hyoid bone.

The students will now examine the parts they have displayed.

Suprahyoid part.—This part of the region is the **submental triangle**, which is bounded inferiorly by the body of the hyoid bone, and, on each side, by the anterior belly of the digastric muscle. Its floor or upper boundary is formed by the mylo-hyoid muscles united by a median fibrous raphe which extends from the symphysis menti to the hyoid bone ; and the *submental lymph-glands* lie on the fascia that covers these muscles. The mylo-hyoid is the chief muscle of the floor of the mouth ; at a later stage, it will be examined fully and reflected, but the student may note now that the muscle which lies alongside the median plane above the mylo-hyoid —*i.e.* deep to it and not yet exposed—is the *genio-hyoid*, and that there is an anastomosis between the *suprahyoid arteries* immediately above the hyoid bone.

Infrahyoid part.—Between the hyoid bone and the sternum, there is a narrow, elliptical median area bounded by the muscles of the two sides. The muscles are :—(1) the sterno-hyoid, (2) the superior belly of the omo-hyoid, lateral to the sterno-hyoid ; (3) the sterno-thyroid and (4) the thyro-hyoid, deep to the sterno-hyoid. Those that form the actual boundaries of the space are the sterno-hyoid superiorly, and the sterno-thyroid inferiorly. Look for the following structures within the space :—

(1) The *median thyro-hyoid ligament*, which is attached, inferiorly, to the upper border of the thyroid cartilage, while, superiorly, it extends upwards behind the body of the hyoid bone to be attached to its *upper* border.

(2) The *hyoid bursa*, placed between the hyoid bone and the thyro-hyoid ligament to lessen friction during the movements of the hyoid bone and the larynx in swallowing.

(3) The anastomosis between the *infrahyoid arteries*, on the surface of the ligament.

(4) The laryngeal prominence, formed by the *thyroid cartilage* ; and (5) the arch of the *cricoid cartilage*.

(6) The *crico-thyroid ligament*, and (7) the anastomosis of the *crico-thyroid arteries*, on its surface.

(8) The *crico-thyroid muscle* on each side of the ligament; it is a laryngeal muscle, and is the only one of them that lies on the exterior of the larynx; it radiates upwards and backwards from the cricoid cartilage to the lower border and inferior horn of the thyroid cartilage, and is to a large extent hidden by the sterno-hyoid.

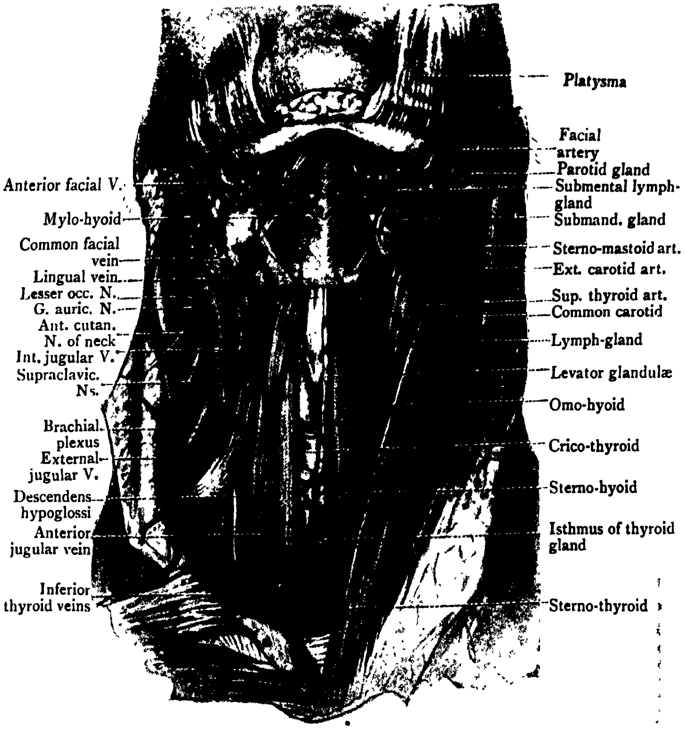


FIG. 56.—Dissection of Front of Neck. The Right Sterno-Mastoid has been removed.

(9) The first ring of the trachea; and (10) the *isthmus of the thyroid gland*, on the second, third and fourth rings.

(11) The anastomosing arteries and veins on the surface of the isthmus.

(12) The *levator glandulæ thyroideæ* is a slender slip of muscle or of fibrous tissue that sometimes extends from the isthmus to the hyoid bone. When present, it is usually on the left side, and is attached to a small pointed process, called the *pyramidal lobe*, which juts upwards from the isthmus.

(13) The *jugular arch*, a short distance above the sternum.

(14) The *inferior thyroid veins*, on the lower cervical part of the trachea.

(15) Occasionally, the *left innominate vein* and the *innominate* artery are high enough up to be in front of the trachea in the root of the neck.

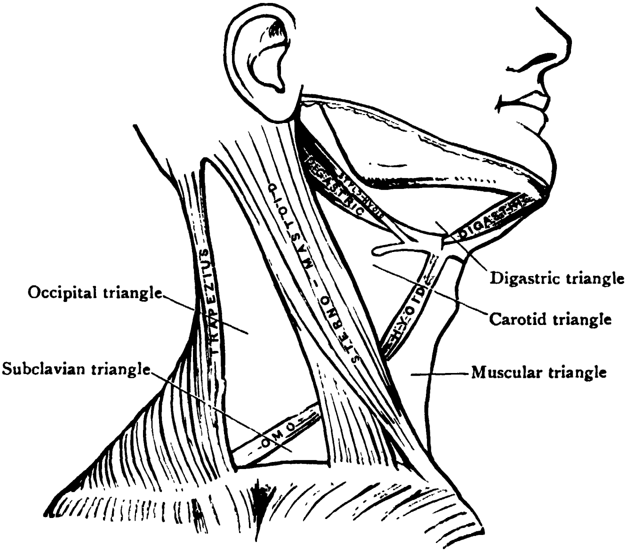


FIG. 57.—Diagram to show Boundaries of Triangles of Neck.

SUBDIVISIONS OF ANTERIOR TRIANGLE.—The anterior triangle of the neck is divided into four triangles—the muscular triangle, the carotid triangle, the digastric triangle, and half of the submental triangle. The submental triangle has been dissected already. The student will now define and clean the contents of the other triangles in turn, beginning with the digastric triangle.

Dissection.—Identify the facial artery and the anterior facial vein at the lower border of the mandible. Cut the deep fascia at its attachment to the mandible and turn it downwards to its attachment to the hyoid bone. The *submandibular salivary gland* is then partly exposed. Identify the anterior and posterior bellies of the *digastric muscle* at the lower border of the gland and follow the *anterior facial vein* downwards and backwards across the gland and the posterior belly.

Find the *submental branch* of the facial artery at the lower border of the mandible, and trace it forwards—pushing aside the submandibular salivary gland and removing the fat and the *submandibular lymph-glands.* The artery falls in with the *mylo-hyoid nerve ;* trace the branches of the nerve into the mylo-hyoid muscle and the anterior belly of the digastric, and then clean the anterior belly.

Raise the lower part of the submandibular gland from the posterior belly and fix it with hooks. Identify the *intermediate tendon* of the digastric, and define the *fascial sling* or pulley that connects it with the hyoid bone. Find the slender slip of muscle—the *stylo-hyoid*—that lies along the upper surface of the posterior belly, and note that its lower part splits to embrace the intermediate tendon. Clean the stylo-hyoid and the posterior belly as far as the angle of the mandible.

Define the posterior border of the mylo-hyoid muscle for some distance above the hyoid bone till the *hypoglossal nerve* and one of the veins of the tongue are found disappearing under cover of it. The thin muscular sheet overlapped by the mylo-hyoid is the *hyo-glossus.* Remove the fat and fascia from the parts of the mylo-hyoid and hyo-glossus now exposed.

Digastric Triangle.—The digastric triangle is bounded by the lower border of the mandible and the two bellies of the digastric—the posterior belly being supplemented by the stylo-hyoid. The floor is formed by a portion of the mylo-hyoid and a portion of the hyo-glossus behind the mylo-hyoid. The triangle forms part of the submandibular region, and its boundaries and contents will be more fully examined when that region is dissected. At this stage, it is enough to note the position of its contents.

The lower part of the **submandibular salivary gland** almost fills the triangle, and may overlap the digastric boundaries. The **submandibular lymph-glands** lie on the surface of the salivary gland, chiefly along the lower border of the mandible. They receive lymph from the tongue and the teeth, the lips and the cheek, and pass it on to lymph-glands that lie deep to the sterno-mastoid.

The **anterior facial vein** pierces the deep fascia at the lower border of the mandible, runs downwards and backwards across the submandibular gland, and ends by joining the anterior branch of the posterior facial vein to form the common facial vein, which usually ends in the internal jugular vein. The **facial artery** (external maxillary) emerges at the lower border of the mandible, and, before it pierces the deep fascia to enter the face, it gives off the **submental artery**, which (with the *submental vein*) runs forwards to join company with the mylo-hyoid nerve.

The **mylo-hyoid nerve** lies on the mylo-hyoid *muscle near* the mandible, and ends in branches that supply the mylo-hyoid muscle and the anterior belly of the digastric. The **hypoglossal nerve** runs forwards on the hyo-glossus muscle, a little above the hyoid bone, and disappears under cover of the mylo-hyoid muscle. A *vein from the tongue* lies below it. The **intermediate tendon** of the digastric lies on the hyo-glossus immediately above the hyoid bone, and is connected with the bone by a loop of fascia through which it moves as through a pulley.

The student will now pass to the study of the carotid triangle—an important region and a difficult one, owing to the large number of vessels and nerves that are crowded together within it.

Dissection.—Remove the remains of the deep fascia from the area between the posterior belly of the digastric and the superior belly of the omo-hyoid, and pull the sterno-mastoid backwards as far as possible. Remove enough of the fat and the lymph-glands from the lateral part of the exposed area for the mere identification of the following large vessels :—

Internal jugular vein, in the most lateral part of the area ;
common and *internal carotid arteries*, medial to the vein ;
external carotid artery, antero-medial to the internal carotid.

The *lingual* and *common facial veins* enter the internal jugular in the upper part of the area, and the *superior thyroid* in the lower part. Find those veins and trace them forwards till they disappear from the triangle.

Identify the *accessory nerve* in the upper angle of the triangle. Then, find the *hypoglossal nerve* as it emerges at the lower border of the posterior belly of the digastric from between the internal jugular and internal carotid. Trace the nerve forwards, till it disappears again ; find also its two branches—its *descendens branch* where it appears, and its *thyro-hyoid branch* near where it disappears—and trace them. The artery that crosses the hypoglossal nerve as it enters the triangle is the *occipital* ; clean it and its branches in the triangle.

Remove the superficial part of the fascial sheath that surrounds the internal jugular vein and the common and internal carotid arteries, avoiding injury to the *descendens hypoglossi* on the surface of the arteries, and a slender nerve called the *descendens cervicalis* on the surface of the vein. Then, clean the external carotid artery, and, after that, its branches.

The *superior thyroid artery* is the lowest branch seen now. Follow it till it leaves the triangle, and then clean the branches which it gives off in the triangle.

The *lingual* and *facial arteries* arise in the upper part of the space; clean the small portions that lie in the space. The *occipital* arises about the same level as the facial, and has been traced. The *ascending pharyngeal* arises from the lower part of the external carotid; but, as it is deep to the internal carotid, its dissection may be deferred.

Find the *internal laryngeal nerve* in the thyro-hyoid interval, and trace it upwards and backwards to its parent trunk—the *superior laryngeal*—which is deep to the carotid artery; secure the *external laryngeal nerve*—a very slender nerve which arises from that trunk—and follow it downwards in the fat which lies deep to the superior thyroid artery.

Clean the small portion of the *hyo-glossus muscle* that lies in the floor of the triangle immediately above the hyoid bone; note the *hypoglossal nerve* on its surface, and the *lingual artery* disappearing under its posterior border. The muscle on which the lingual artery lies before it disappears is part of a fan-shaped muscle called the *middle constrictor* of the pharynx. Push up the posterior belly of the digastric, and clean the portion of the middle constrictor that lies near the hyoid bone.

Clean the part of the *thyro-hyoid* muscle that lies in the floor of the triangle. Then, pushing the superior thyroid and the carotid arteries backwards, remove the fat in which the external laryngeal nerve lies, and disclose a portion of a muscle called the *inferior constrictor* of the pharynx, which curves backwards from the side of the larynx.

Separate the internal jugular vein from the carotid arteries, and find the *vagus nerve* in the posterior part of their sheath. Then, push the carotid arteries medially, and, with a blunt hook, extricate a nerve cord—the *sympathetic trunk*—from the posterior wall of the fascial sheath, behind the carotid arteries.

The *cervical plexus*, which lies behind the upper part of the internal jugular vein, will be dissected later.

Carotid Triangle.—This space is so named because portions of all three carotid arteries lie within it. But, in a description of the contents of the triangle, it is always assumed that the sterno-mastoid is pulled back. Otherwise, the triangle would scarcely merit the name of "carotid," for, in the undissected neck, the fascial connexions of the sterno-mastoid keep it braced forward so far that the triangle is of very small dimensions, and, even when the fascial connexions are loosened by dissection, portions of the carotid arteries are seen only in the upper part of the triangle unless the sterno-mastoid is retracted.

The triangle is bounded by the sterno-mastoid, the posterior belly of the digastric and the superior belly of the omo-hyoid. The hyo-glossus and thyro-hyoid muscles form the anterior part of its floor, while the posterior part is formed by the middle and inferior constrictor muscles of the pharynx.

Most of the contents of the triangle will be dealt with later when they can be studied in their whole course; but their relative positions in the triangle must be examined now.

The **internal jugular vein** is the largest of the contents. It descends vertically in the most lateral part of the triangle. The **common carotid artery** is on the medial side of the vein, in the lower part of the triangle. It ends in the triangle, at the level of the upper border of the thyroid cartilage by dividing into the external and internal carotid arteries. The **internal carotid artery** ascends in the line of the common carotid, along the medial side of the vein. The vein is enveloped, with the common and internal carotid arteries, in a fascial tube called the *carotid sheath,* which, to a large extent, has been destroyed in the last steps of the dissection. The **vagus nerve** descends, within the sheath, behind and between the vein and the arteries; and the **sympathetic trunk** is embedded in the wall of the sheath behind the arteries. Numerous **lymph-glands,** both large and small, lie on the surface of the sheath and at its sides; they receive lymph from the adjoining parts and also lymph transmitted to them by the glands that lie higher in the neck and in the head; and they pass the lymph on to the glands in the root of the neck.

The **external carotid artery** ascends along the side of the pharynx, antero-medial to the internal carotid; it gives off most of its branches in the triangle—superior thyroid, ascending pharyngeal, lingual, facial, and occipital.

The **superior thyroid artery** arises from the lower part of the external carotid, runs forwards and downwards with a curve, and disappears by passing under the omo-hyoid. Three of its branches arise in the triangle:—The *infrahyoid artery* runs to the hyoid bone, and disappears under the thyro-hyoid muscle. The *superior laryngeal artery* pierces the thyro-hyoid membrane under cover of the posterior border of the thyro-hyoid muscle. The *sterno-mastoid branch* runs along the posterior border of the omo-hyoid, across the common carotid artery, to enter the sterno-mastoid. The **superior thyroid vein** runs with it or a little above it, and ends in the internal jugular or in the common facial vein.

The **ascending pharyngeal** is a small artery that arises from the lower part of the external carotid, and runs upwards between the internal carotid and the side of the pharynx.

The **lingual artery** arises behind the tip of the greater horn of the hyoid bone. It runs forwards on the middle constrictor, making a bend, convex upwards, above the tip of the greater horn; and it disappears under the hyo-glossus. Before it disappears it gives off the *suprahyoid artery*, which runs forwards superficial to the hyo-glossus.

The **facial artery** arises above the lingual, and leaves the triangle at once by ascending under cover of the posterior belly of the digastric.

The **occipital artery** arises at the same level as the facial. It runs backwards and upwards along the lower border of the posterior belly of the digastric and disappears at the upper angle of the triangle. On its way, it crosses the internal carotid artery, the hypoglossal nerve, the internal jugular vein and the accessory nerve. It gives off a *sterno-mastoid branch* as it crosses the hypoglossal nerve; and, as it crosses the internal jugular vein, it sends a *meningeal branch* upwards along the vein into the skull, and another *sterno-mastoid branch* to accompany the accessory nerve.

The **accessory nerve** runs downwards and backwards across the upper corner of the triangle, usually superficial to the internal jugular vein.

The **hypoglossal nerve** appears between the internal jugular vein and the internal carotid artery at the lower border of the posterior belly of the digastric, and curves forwards along the posterior belly, crossing the internal and external carotid arteries and the bend of the lingual artery, and disappears under the posterior belly again to enter the digastric triangle. In the carotid triangle it gives off two branches:—The *descendens hypoglossi* arises as soon as the hypoglossal enters the triangle, and it runs downwards over the internal and common carotid arteries. The *thyro-hyoid nerve* arises at the lingual artery and runs downwards and forwards into the thyro-hyoid muscle.

The **descendens cervicalis** is a slender nerve that arises by two roots from the anterior primary rami of the second and third cervical nerves. The roots arise behind the internal jugular vein, curve forwards round the vein, usually on its lateral surface, and unite to form a single stem which descends over the vein. After leaving the triangle, it passes on to the common carotid artery and joins the descendens hypoglossi to form a loop called the *ansa hypoglossi*; the ansa lies on the common carotid opposite the lower part of the larynx and sends branches to the sterno-hyoid, the sterno-thyroid, and both bellies of the omo-hyoid.

The **anterior facial vein** crosses the posterior belly of the digastric and enters the carotid triangle. It unites with the anterior branch of the posterior facial to form the **common facial vein.** The common facial is very variable in length and direction; usually it crosses the external and internal carotid arteries, and ends in the internal jugular vein. It may be joined by the lingual vein and the superior thyroid veins.

The **lingual vein** is formed at the posterior border of the hyo-glossus by the union of veins that accompany the lingual artery and the hypoglossal nerve. It crosses the carotid arteries and ends either in the common facial or in the internal jugular vein.

Muscular Triangle.—This space is bounded by the sterno-mastoid, the superior belly of the omo-hyoid and the median line of the neck. Its floor is formed by the portions of the sterno-hyoid and sterno-thyroid that were cleaned when the median line of the neck was examined. Its only contents are areolar tissue and minute vessels. The muscles in its floor, and the other two infrahyoid muscles, should now be examined.

Dissection.—**Divide the sternal head of the sterno-mastoid about an inch above its origin; turn the lower part downwards, and clean the portion of the *anterior jugular vein* that lies behind it. Push the upper part of the sterno-mastoid aside till the intermediate tendon of the omo-hyoid is found. Carefully raise the *superior belly of the omo-hyoid* and secure its nerve. Trace the nerve to its origin from the *ansa hypoglossi*; define the ansa and then secure and trace the other branches that spring from it.**

Next, clean the *sterno-hyoid* and the *superior belly of the omo-hyoid*, taking care of their nerves. Push the handle of the knife gently downwards between the sternum and the sterno-hyoid to ascertain the line of attachment of the muscle to the sternum. Then, cut the sterno-hyoid low down—below the entrance of its nerve—and reflect it upwards to the hyoid bone. That exposes the greater part of the *sterno-thyroid* and *thyro-hyoid*; push the omo-hyoid aside to expose them more fully; clean their surfaces and define their margins, taking care of their nerves; and push the handle of the knife downwards in front of the sterno-thyroid till its line of origin is reached.

INFRAHYOID MUSCLES.—These ribbon-like muscles—the sterno-hyoid, sterno-thyroid, thyro-hyoid, and omo-hyoid—are attached to the thyroid cartilage and the hyoid bone.

They lie upon the thyroid gland, trachea, larynx and thyro-hyoid membrane, and are disposed in two strata—the sterno-thyroid and thyro-hyoid forming the deeper layer. The thin fascia which ensheaths them is connected by areolar tissue with the second and third layers of fascia of the neck, and, being connected inferiorly with the sternum, clavicle and first rib, it holds the tendon of the omo-hyoid down in place.

They are supplied, through the thyro-hyoid nerve and the ansa hypoglossi, by the first, second and third cervical nerves. The nerves to the sterno-hyoid, sterno-thyroid and the superior belly of the omo-hyoid enter these muscles below their middle. The infrahyoid muscles are called into use during the movements of the larynx and the hyoid bone in vocalisation and in swallowing.

Sterno-Hyoid.—The sterno-hyoid arises from the back of the manubrium sterni and the medial end of the clavicle, and is inserted into the lower border of the hyoid bone alongside the median plane. It lies on the sterno-thyroid and thyro-hyoid. Its lower part is concealed by the sterno-mastoid and is crossed by the anterior jugular vein ; its upper part is covered with skin and fasciæ only.

Omo-Hyoid.—The omo-hyoid has two bellies united by a tendon. The *tendon* lies on the internal jugular vein, under cover of the sterno-mastoid, at the level of the cricoid cartilage, and is held in place by a sheet of fascia that extends downwards from it to be attached to the sternum, the clavicle and the first costal cartilage. The *inferior belly* is described on p. 54. The *superior belly* springs from the tendon, passes upwards almost vertically and is inserted into the body and greater horn of the hyoid bone immediately lateral to the sterno-hyoid. It crosses the common carotid artery and then lies on the sterno-thyroid and the thyro-hyoid. The sterno-mastoid conceals it at first ; afterwards, it is covered with skin and fasciæ only.

Sterno-Thyroid.—The sterno-thyroid is shorter and wider than the sterno-hyoid, and, being deeper, its origin is lower down. It arises from the back of the manubrium and first costal cartilage, and is inserted into the oblique line on the lateral surface of the thyroid cartilage. It lies at first in front

PLATE VII

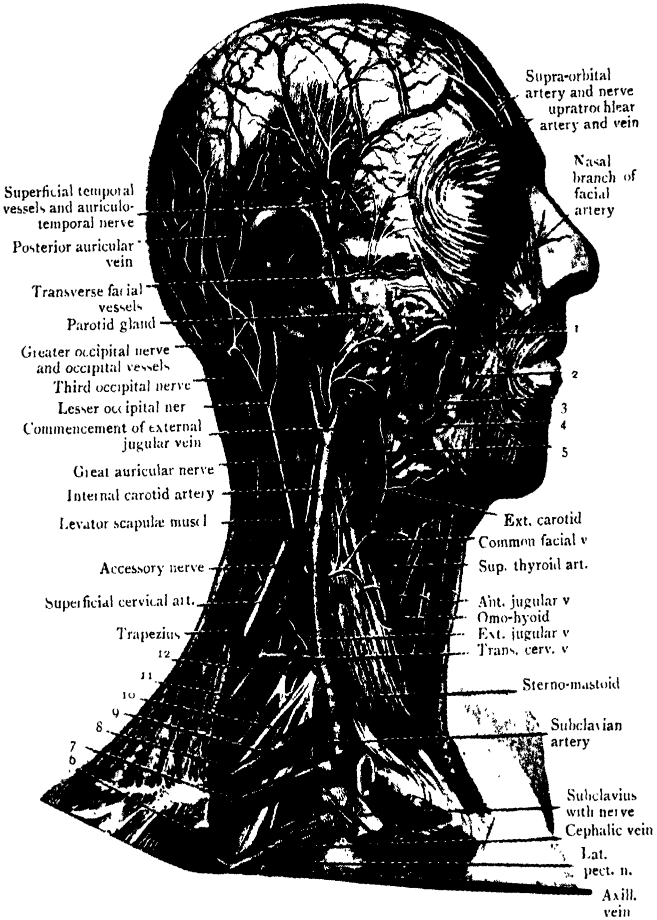


FIG. 58.– Side of Head and Triangles of Neck.

1 Superior labial branch of facial artery.
2. Inferior labial branch of facial artery.
3. Anterior facial vein.
4. Facial artery.
5. Cervical branch of facial nerve communicating with anterior cutaneous nerve of neck.
6. Acromial branch of acromio-thoracic artery.
7. Suprascapular vessels.
8. First serration of serratus anterior muscle.
9. Omo-hyoid muscle (inferior belly).
10. Suprascapular nerve.
11. Transverse cervical artery on scalenus medius muscle.
12. Upper root of nerve to serratus anterior.

PLATE VIII

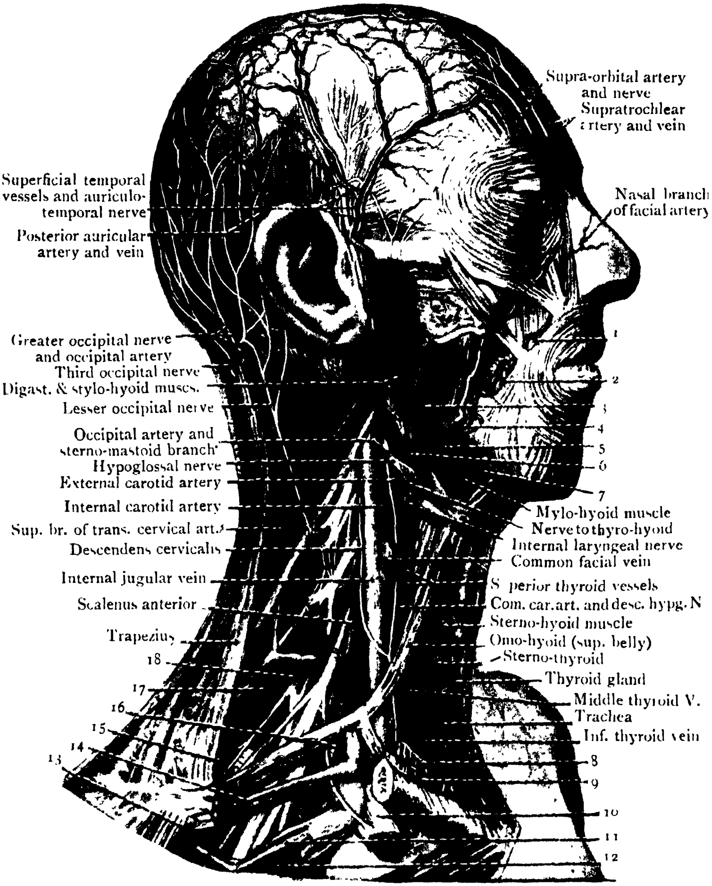


FIG. 59.—Deep Dissection of Neck. Compare Fig. 58.

1. Superior labial branch of facial artery.
2. Inferior labial branch of facial artery.
3. Facial (external maxillary) artery.
4. Facial artery.
5. Deep part of submandibular gland.
6. Lingual artery.
7. Submental artery.
8. Sterno-thyroid muscle.
9. Sterno-hyoid muscle.
10. Subclavius muscle with nerve.
11. Cephalic vein.
12. Lateral pectoral (anterior thoracic) nerve.
13. Acromial branch of acromio-thoracic artery.
14. Suprascapular vessels.
15. First serration of serratus anterior muscle.
16. Subclavian artery.
17. Transverse cervical artery.
18. Upper root of the nerve to serratus anterior

of the large vessels in the upper part of the thorax and in the root of the neck, and then on the thyroid gland, and its attachment to the thyroid cartilage limits the upward reach of that gland.

Thyro-Hyoid.—The thyro-hyoid is an upward continuation of the sterno-thyroid. It arises from the oblique line of the thyroid cartilage, and is inserted into the lower border of the greater horn of the hyoid bone. It lies on the thyroid cartilage and the thyro-hyoid membrane, and is largely concealed by the omo-hyoid and the sterno-hyoid.

If the Thorax has not yet been allotted for dissection, the students will now return to the head and will remove the parotid gland and dissect the structures in the infratemporal fossa and submandibular region. These parts overlie the deep structures in the upper part of the neck and require to be removed or displaced before all the vessels and nerves can be followed in the whole of their cervical course.

But if the dissection of the Thorax has been begun, the dissectors of the Neck should now dissect and study the parts in the root of the neck (pp. 203-226) before they are disturbed by the dissectors of the Thorax. When that has been done, the dissectors of the Neck will dissect the parotid region and the regions that succeed it in preparation for the deep dissection of the upper part of the neck.

Before proceeding to the parotid region, replace the displaced infrahyoid muscles, the sterno-mastoid and what remains of the skin, and wrap the whole neck up in cloth soaked with preservative liquid.

PAROTID REGION

In this region the following structures are examined:—(1) The parotid gland and its duct; (2) the structures within the parotid gland, the chief of which are the posterior facial vein, a portion of the external carotid artery and a portion of the facial nerve; (3) the structures in immediate relation to the deep surfaces of the parotid gland.

Parotid Gland (Figs. 8, 60-64).—This is the largest of the salivary glands, and assumes a very irregular shape in order to accommodate itself to its surroundings. It is wedged into the triangular hollow behind the mandible, and it extends upwards to the external auditory meatus, downwards beyond the angle of the mandible to overlap the carotid sheath in the carotid triangle (Fig. 58), and medially to the styloid process—*i.e.* almost to the side of the pharynx. Posteriorly, it overlaps the sterno-mastoid; anteriorly, it overflows the space still farther—extending forwards for a variable distance over the masseter. A portion of that *facial process* is usually more or less detached, and is called the **accessory parotid gland.**

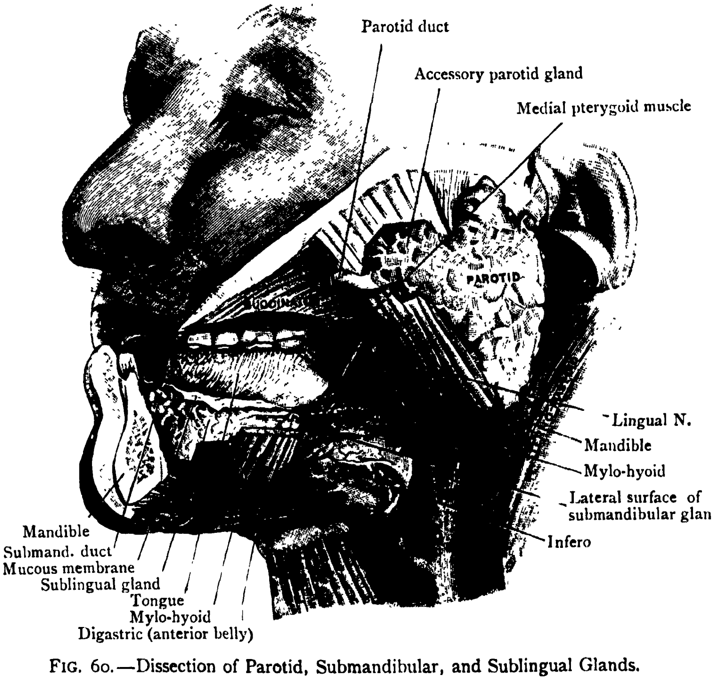


FIG. 60.—Dissection of Parotid, Submandibular, and Sublingual Glands.

The gland is enclosed in a sheath of fascia prolonged upwards from the neck. A portion of the deep part of the sheath is called the *stylo-mandibular ligament*; it extends from the lateral border of the styloid process to the posterior border of the mandible above the angle, and separates the lower part of the parotid gland from the submandibular gland.

You have already found branches of the facial nerve and other structures as they emerged at the ends and anterior border of the gland (p. 27); and you have traced branches of the great auricular nerve into it through the lower part of its superficial surface (p. 48). Identify those structures again, and turn to those pages to refresh your memory.

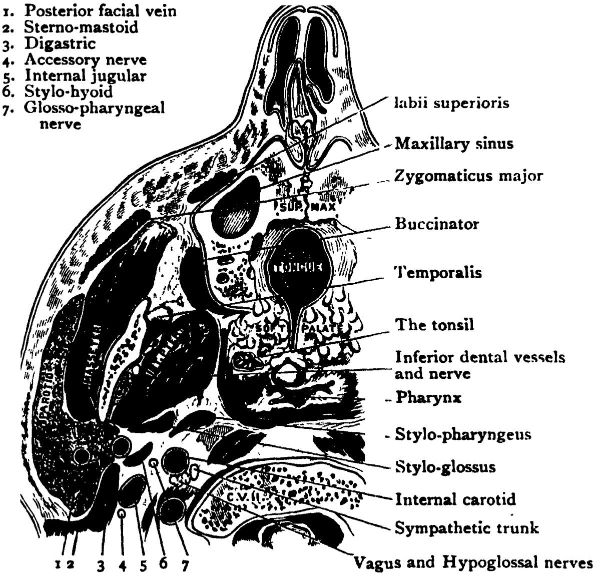


FIG. 61.—Transverse Section through Head at level of Hard Palate. It shows the relations of the Parotid Gland, etc.

Parotid Duct.—The parotid duct is a thick-walled tube formed within the gland by the union of the ductules that remove the secretion of its lobules; and it is one of the structures that appear at the anterior border of the gland at the level of the lobule of the ear. The duct runs forwards across the masseter, below the accessory parotid gland and in company with branches of the facial nerve. At the anterior border of the masseter, it turns sharply in a medial direction and pierces the buccal pad of fat, the bucco-pharyngeal fascia, the buccinator muscle and the mucous membrane of the cheek, to open into the vestibule of the mouth on the apex of a little papilla opposite the second upper molar tooth.

Structures within Parotid Gland.—These are the following:—(1) The facial nerve and its terminal branches. (2) Small communicating branches to the facial nerve from the great auricular nerve, and larger ones from the auriculotemporal nerve. (3) The posterior facial vein. (4) The external carotid artery. (5) Small lymph-glands.

The vein is superficial to the artery. Both of them are, in reality, in a groove in the gland ; but the groove is deep and its margins meet, and the vessels are therefore enclosed in the gland.

The *external carotid artery* enters and leaves the gland on its deep surface. Immediately before it enters, it gives off the posterior auricular artery ; and, as it emerges, behind the neck of the mandible, it divides into its two terminal branches—the maxillary and the superficial temporal. The superficial temporal, while under cover of the gland, gives off the transverse facial and middle temporal arteries.

The *posterior facial vein* receives the maxillary vein (or veins) and the transverse facial vein ; and, near the lower end of the gland, it divides into an anterior branch and a posterior branch.

The *facial nerve* enters the posterior part of the deep surface of the gland, and divides into five terminal branches (p. 31) which pass forwards usually superficial to the posterior facial vein but sometimes between the vein and the artery; these five branches diverge from one another and subdivide further into branches that radiate from the ends and the anterior border of the gland.

The *parotid lymph-glands* are embedded partly in the superficial surface of the gland and partly in its substance. Those on the surface receive lymph from the auricle, the anterior part of the scalp and the upper part of the face ; those in the substance receive lymph from the external auditory meatus, the middle ear and pharyngo-tympanic tube, the nose and the palate, and the deep parts of the cheek. Both groups transmit the lymph to the glands in the neck.

Dissection.—Clean the fascia from the surface of the parotid gland. Remove the superficial part of the gland piecemeal, and trace the _branches of the facial nerve_ backwards through it to the trunk of the nerve. As you do so, look for the _communicating_

branches **from the great auricular and auriculo-temporal nerves ; it is difficult to find those from the great auricular ; but those from the auriculo-temporal are relatively large. Then, trace the trunk of the facial nerve towards the stylo-mastoid foramen, secure the branches which arise from it before it enters the gland ; and clean the** ***posterior auricular artery,*** **which will be found at the same time.**

Next, removing more of the gland, clean the ***posterior facial vein*** **and its tributaries, and the** ***external carotid artery*** **and its branches.**

Finally, remove the remainder of the gland, and clean the structures that bound the recess in which it lay. To do so, it will be necessary :—(1) to divide the facial nerve at the point where it entered the gland and turn the nerve and its terminal branches forward ; (2) to remove the posterior facial vein ; (3) to divide the external carotid artery above its posterior auricular branch, and turn the upper part upwards.

The dissectors will now study the relations of the parotid gland, and it will be of advantage if they can obtain a gland that has been removed uninjured or a cast of a gland.

External Characters and Relations of Parotid Gland.—The parotid gland has two ends—upper and lower—and three surfaces — superficial, antero-medial and postero-medial.

The *upper end* is a concave surface rather than an end. It is closely related to the external auditory meatus, and its anterior margin is wedged in between the meatus and the back of the mandibular joint. The auriculo-temporal nerve, the superficial temporal artery and the temporal branches of the facial nerve appear on the surface of the head at the upper end of the gland, and the posterior facial vein disappears at that point.

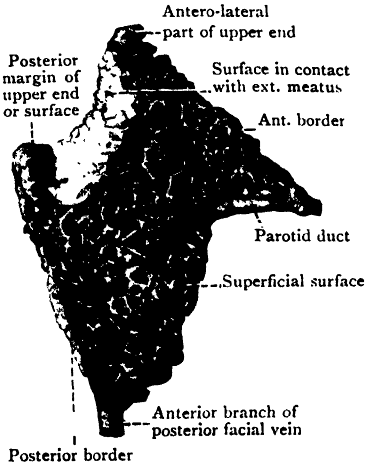

Antero-lateral part of upper end
Posterior margin of upper end or surface
Surface in contact with ext. meatus
Ant. border
Parotid duct
Superficial surface
Anterior branch of posterior facial vein
Posterior border

FIG. 62.—Parotid Gland, lateral surface.

The *lower end* is wedged in between the angle of the mandible and the sterno-mastoid. It lies on the posterior belly of the digastric, but may extend downwards over it to overlap the carotid sheath. The cervical branch of the facial nerve and the two branches of the posterior facial vein emerge at the lower end.

The superficial or *lateral surface* is nearly flat, and of irregular outline. It is covered with skin, superficial fascia and deep fascia; and a few, small lymph-glands are embedded in it. Various structures that have been seen already emerge from under cover of its anterior border—the transverse facial artery, the parotid duct, and the zygomatic, buccal and mandibular branches of the facial nerve.

The *antero-medial surface* is highly concave, for it clasps the posterior parts of the masseter, mandible and medial pterygoid muscle. The lower part is related also to the posterior end of the submandibular gland, from which it is separated by the part of the fascial sheath called the stylo-mandibular ligament. The external carotid artery emerges from the upper part of this surface and the posterior facial vein enters it.

The *postero-medial surface* is uneven. It is related to :—(1) The mastoid process and the sterno-mastoid. (2) More deeply, the posterior belly of the digastric and the stylo-hyoid, cular artery along the upper border of the digastric. (3) More deeply still, the styloid process, the carotid cranial nerves. The external carotid artery enters this surface above the digastric; the cervical branch of the facial nerve and the branches of the posterior facial vein emerge below the digastric. The facial nerve enters between the digastric and the styloid process.

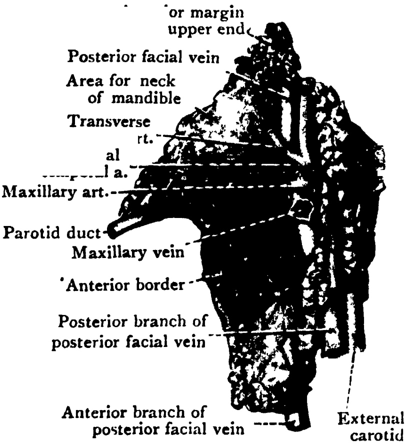


FIG. 63.—Parotid Gland, antero-medial surface.

Vessels and Nerves.—The parotid gland receives its vascular supply from neighbouring vessels. Its nerves are the great auricular, the sympathetic plexus around the external carotid artery, and the auriculo-temporal nerve, which conveys parasympathetic secretory fibres to it—derived indirectly from the glosso-pharyngeal nerve and relayed to the auriculo-temporal from the otic ganglion (p. 182).

Facial Nerve.—The facial nerve is the seventh cranial nerve, and was seen when the cerebellum was removed. It emerges from the brain at the lower border of the pons, passes, with the auditory nerve, into the internal auditory meatus, and, after a devious journey through the temporal bone, it leaves the skull through the stylo-mastoid foramen. Its intra-cranial course and branches will be studied later.

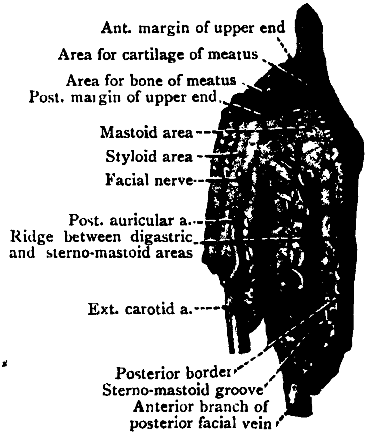


FIG. 64.—Parotid Gland, postero-medial surface.

After emerging from the stylo-mastoid foramen, it curves forwards round the lateral side of the styloid process and internal jugular vein, and sinks into the postero-medial surface of the parotid gland. Before it enters the gland, it gives off:—(1) the posterior auricular nerve, and (2) a branch that divides into two twigs to supply the stylo-hyoid muscle and the posterior belly of the digastric. As it passes through the parotid gland it divides into five branches or sets of branches—temporal, zygomatic, buccal, mandibular and cervical. They pass forwards radiating from one another, and receiving communicating branches from the great auricular and the auriculo-temporal nerves. They usually pass superficial to the posterior facial vein, but some of them may pass between the vein and the external carotid artery; and they emerge through the deep surface of the gland near its ends and anterior border. In thin people, the temporal and zygomatic branches can be felt as they cross the lateral border of the neck of the mandible.

TEMPORAL AND INFRATEMPORAL REGIONS

Revise the superficial part of the temporal region which has been dissected already (p. 11); by that dissection the temporal fascia was exposed.

Temporal Fascia.—The temporal fascia is a strong, glistening membrane which is stretched over the temporal fossa, binding down the temporal muscle. Superiorly, it is attached to the upper temporal line. Inferiorly, it splits into two laminæ which are separated from each other by fat which contains small vessels including the zygomatic branch of the superficial temporal artery. The superficial lamina is attached to the upper border of the zygomatic arch, and the other is continuous with the fascia on the deep surface of the upper part of the masseter. Cut the superficial lamina, and explore the connexions of the deeper layer with the handle of the knife. In its upper part, the temporal fascia is comparatively thin and the fibres of the temporal muscle may be seen shining through it; below, it is thicker, and, owing to the fat between its laminæ, it is perfectly opaque. The middle temporal vessels pierce it immediately above the zygoma close to the auricle, and the zygomatico-temporal nerve pierces it behind the frontal process of the zygomatic bone.

Masseter.—The masseter is a thick, quadrate muscle which covers the ramus of the mandible. It arises from the lower border and deep surface of the zygomatic arch (Fig. 2). The deep fibres are vertical; the superficial fibres pass downwards and backwards. It is inserted into the lateral surface of the ramus and coronoid process of the mandible and completely conceals them; but note that it does not cover the head and neck of the mandible, and that they can be felt behind it in the living head.

The masseter raises the mandible and helps to protract it. Its nerve is derived from the mandibular nerve.

Dissection.—Turn the upper part of the posterior margin of the masseter forwards and secure its nerve and artery.

To display the *temporal muscle*:—Remove first the deep layer of the temporal fascia—preserving the middle temporal vessels and the zygomatico-temporal nerve. Then, divide the zygomatic arch behind and in front of the masseter; use the saw at first, and then complete the division with the bone-forceps.

Make the posterior cut immediately in front of the tubercle of the zygoma ; the anterior cut must extend obliquely through the zygomatic bone, from the extreme anterior end of the upper margin of the arch, downwards and forwards to the point where the lower margin meets the zygomatic process of the maxilla.

Turn the arch and the attached masseter muscle downwards, and, as that is being done, cut the artery and nerve of supply out of the muscle, leaving a small portion attached to them by which they may be identified later. Divide any fibres of the temporal muscle that join the masseter and hamper the reflexion.

Strip the masseter from the surface of the mandible as far as the angle, but leave it attached to the angle ; and clean the temporal muscle.

Temporalis.—The temporal muscle is fan-shaped. It arises from the whole of the floor of the temporal fossa (Fig. 2), and receives additional fibres from the temporal fascia. From this broad origin the fasciculi converge upon the coronoid process of the mandible. The anterior fibres descend vertically, the posterior at first pursue a nearly horizontal course, and the middle fibres proceed with varying degrees of obliquity. A tendon developed on the lower part of its superficial surface is inserted into the summit and anterior edge of the coronoid process and extends downwards along the anterior edge of the ramus. The deep part of the muscle remains fleshy, and gains insertion to the medial surface of the coronoid process—an attachment which, becoming tendinous, reaches as low down as a point behind the third molar tooth, where the anterior margin of the ramus merges into the body of the mandible. In many cases, some of the superficial fibres join the masseter and gain insertion into the mandible through it. The whole insertion cannot be fully examined at present ; it will be dealt with later.

The temporal muscle raises the mandible and retracts it after protraction. It is supplied by the deep temporal branches of the mandibular nerve.

Dissection.**—Detach the coronoid process by an oblique cut made from the middle of the mandibular notch to the point where the anterior margin of the ramus meets the body of the mandible. Use the saw at first, and then complete the division with the bone-forceps, and cut across the tendinous fibres of the temporal muscle that pass below the line of section. The *buccal nerve* and its companion *artery* are in a position of danger during this dissection, and must be carefully guarded. They proceed downwards and forwards, under cover of the lower part of the temporal muscle or through its substance ; as the nerve is parallel to the tendinous fasciculi and often embedded among**

them, it may easily be destroyed during removal of the coronoid process.

Throw the coronoid process and the temporal muscle well upwards, and, with the handle of the knife, separate the muscular fibres from the bone of the lower part of the temporal fossa, in order to expose the *deep temporal nerves* and *arteries* as they ascend between the cranial wall and the muscle. The *middle temporal artery* also will be exposed as it extends upwards upon the squamous part of the temporal bone. Trace the *zygomatico-temporal nerve* (p. 17) to the minute aperture through which it emerges from the temporal surface of the zygomatic bone.

To open up the infratemporal region fully, remove a portion of the ramus of the mandible. Make two horizontal cuts—one through the neck of the mandible, and the other immediately above the mandibular foramen. To find the level of the foramen, thrust the handle of the knife between the ramus and the subjacent soft parts, and carry it downwards. Its progress will soon be arrested by the entrance of the *inferior dental vessels* and *nerve* into the foramen, and the lower border of the instrument will correspond with the line along which the bone should be cut. Use the saw until the bone is cut through half-way, and complete the division with the bone-forceps. Remove the piece of bone, and a quantity of fatty areolar tissue is exposed. Carefully remove this tissue and expose the muscles, vessels and nerves. If the veins are in the way they may be removed.

Superficial Contents of Infratemporal Fossa.—When the fatty areolar tissue is cleared away, the pterygoid muscles are brought into view, and also the vessels and nerves related to their borders and superficial surfaces, but the deeper structures are not yet in view.

Of the structures now seen, the upper muscle is the *lateral pterygoid.* It has two heads—an upper and a lower—which pass backwards converging on the neck of the mandible. The lower muscle is the *medial pterygoid.* Its direction is downwards and backwards. It also has two heads—superficial and deep. The deep head is the main part of the muscle and appears at the lower border of the lateral pterygoid. The superficial head is very small, and lies superficial to the anterior end of the lower head of the lateral pterygoid.

The chief artery of the space is the *maxillary artery*—a terminal branch of the external carotid. It passes forwards, first below the lateral pterygoid, next on the surface of its lower head, and then between the two heads to disappear into a space called the pterygo-palatine fossa. Occasionally it passes forwards deep to the lower head of the lateral pterygoid, and re-appears between the two heads before it enters the pterygo-palatine fossa. As it passes forwards, it gives off numerous branches which pass in various directions. The veins corresponding to those branches anastomose freely, forming a network around the lateral pterygoid muscle called the *pterygoid plexus*. From the network, one or two *maxillary veins* arise and pass backwards below the artery to end in the posterior facial vein.

The *spheno-mandibular ligament* is a thin fibrous ribbon that springs from the spine of the sphenoid. At present, its upper part is hidden by the lateral pterygoid muscle. It emerges at the lower border of that muscle and runs downwards on the surface of the medial pterygoid muscle to be attached to the lower edge of the mandibular foramen.

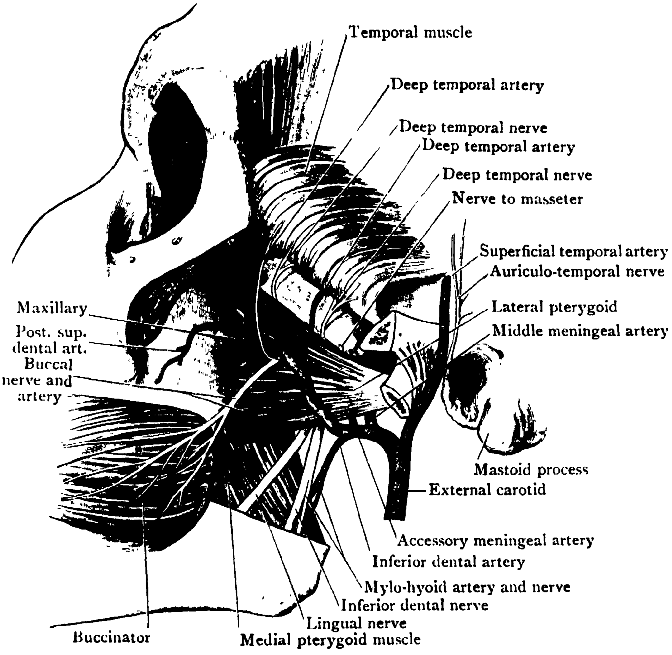


FIG. 65.—Dissection of the Infratemporal Fossa.

The nerves exposed are all derived from the *mandibular nerve*, which lies hidden on the medial side of the lateral pterygoid muscle. These nerves, therefore, have to escape from under cover of that muscle ; and, after they appear, they are joined by branches of the maxillary artery which receive the same names as the nerves.

Two *deep temporal nerves* appear at the upper border of the lateral pterygoid muscle, and, clinging to the bone, they pass upwards into the temporal muscle to supply it. The *nerve to the masseter* also appears at the upper border—farther back. The *buccal nerve* appears between the two heads of the lateral pterygoid, and runs downwards and forwards over the lower head. The *lingual nerve* appears at the lower border of the lateral pterygoid, and runs downwards and forwards on the surface of the medial pterygoid. The *inferior dental nerve* appears immediately behind the lingual, and runs downwards and forwards to the mandibular foramen ; on its way, it gives off the *mylo-hyoid nerve*, which, in its descent, pierces the spheno-mandibular ligament.

A little dissection in the interval above the point where the maxillary artery disappears will discover a small part of the *maxillary nerve* and the two branches which it gives off in this region—the *zygomatic* and the *posterior superior dental.*

Dissection.—**Carefully remove the fat from the interval indicated above and find the trunk of the *maxillary nerve* as it approaches the inferior orbital fissure to become the infra-orbital nerve. Secure and trace (1) the *zygomatic nerve*, which runs forwards through the inferior orbital fissure, and (2) the *posterior superior dental nerve*, which divides into branches that descend and disappear into small holes in the back of the maxilla.**

Having noted the relative positions of the structures exposed, the dissectors will study the connexions of the pterygoid muscles and the relations of the maxillary artery, and will then examine the mandibular joint.

Pterygoideus Lateralis (M. Pt. Externus).—The lateral pterygoid muscle arises by two heads—upper and lower. The *upper head* is the smaller, and springs from the infratemporal ridge and infratemporal surface of the greater wing of the sphenoid ; the *lower head* takes origin from the lateral surface of the lateral pterygoid plate. The muscle diminishes in width as it passes backwards, and it is inserted into the front of the neck of the mandible, and also into the capsule of the mandibular joint and, through it, into the articular disc. It protrudes and depresses the mandible and pulls it towards the opposite side. It is supplied by a branch of the mandibular nerve.

Pterygoideus Medialis (M. Pt. Internus).—The medial pterygoid muscle also is bicipital at its origin, and its two heads embrace the origin of the lower head of the lateral pterygoid. The *superficial head* is a small slip that springs chiefly from the maxillary tuberosity. The *deep head* forms nearly the whole muscle, and its upper part is hidden by the lateral pterygoid. It arises, in the pterygoid fossa, chiefly from the medial surface of the lateral pterygoid plate. The two heads of the muscle unite at the lower margin of the anterior part of the lateral pterygoid, and the fibres proceed downwards, with a postero-lateral inclination, and gain insertion into a rough area between the mandibular foramen and the angle of the mandible. It raises the mandible, protrudes it, and pulls it towards the opposite side. It is supplied by a branch of the mandibular nerve.

Maxillary Artery (A. Maxillaris Interna).—The maxillary artery is the larger of the two terminal branches of the external carotid artery. It takes origin immediately behind the neck of the mandible, and passes forwards to the anterior part of the infratemporal fossa, where it disappears from view by dipping between the two heads of the lateral pterygoid muscle and entering the pterygo-palatine fossa. It is divided into three parts, for convenience of description. The *first part* runs horizontally between the neck of the mandible and the spheno-mandibular ligament. It lies along the lower border of the posterior part of the lateral pterygoid muscle, and usually crosses the inferior dental nerve superficially. The *second part* extends obliquely upwards and forwards on the lateral surface of the lower head of the lateral pterygoid muscle, under cover of the insertion of the temporal muscle. The *third part* dips between the two heads of the lateral pterygoid, and ends in the pterygo-palatine fossa by breaking up into several branches.

The arrangement described is that most frequently found, but it is not uncommon to find the second part of the artery lying in a deeper plane, viz., between the medial and lateral pterygoid muscles. In that case the vessel makes a bend laterally between the heads of the lateral pterygoid muscle before it enters the pterygo-palatine fossa.

During its course the artery gives off numerous branches.

They supply the external auditory meatus and the middle ear, the muscles of the region, the skull bones and the dura mater; and many of them accompany the nerves that arise in the infratemporal and pterygo-palatine fossæ. The most important branch is the *middle meningeal*; since it passes upwards under cover of the lateral pterygoid, it cannot be studied till that muscle is reflected.

The *inferior dental artery* (inferior alveolar) also is an important artery as it supplies the teeth of the lower jaw. It descends, immediately behind the inferior dental nerve, to enter the mandibular canal through the mandibular foramen. Before it reaches the foramen it gives off a slender branch to accompany the mylo-hyoid nerve for a short distance; and, near its termination, it sends a branch out through the mental foramen. Its *venæ comitantes* almost fill the mandibular foramen; and they end in the pterygoid plexus.

Pterygoid Plexus and Maxillary Vein.—The veins of the infratemporal fossa are very numerous, but they cannot be studied satisfactorily in an ordinary dissection. They anastomose together around the lateral pterygoid muscle to form a dense network termed the *pterygoid plexus*. The veins that correspond to the branches of the maxillary artery open into the network; and the blood is led away from its posterior part by a short, wide trunk called the *maxillary vein*. That vessel accompanies the first part of the maxillary artery to the parotid gland, where it joins the posterior facial vein behind the neck of the mandible. Sometimes there are two maxillary veins.

The pterygoid venous plexus is connected with the cavernous sinus by an emissary vein which passes through the foramen ovale or through the emissary sphenoidal foramen. The plexus communicates with the inferior ophthalmic vein through the inferior orbital fissure, and with the anterior facial vein by an anastomosing channel, called the *deep facial vein*, which springs from the anterior facial, and passes backwards on the buccinator muscle, and under cover of the masseter and ramus of the mandible, to join the plexus.

Before the lateral pterygoid muscle is thrown forwards, the mandibular joint must be examined.

Mandibular Joint.—This joint is the articulation of the head of the mandible with the articular fossa and articular eminence of the temporal bone. It is a synovial joint; and its cavity is separated into an upper and a lower part by an articular disc.

The **capsular ligament** is attached *superiorly* to the temporal bone around the margins of the articular fossa and eminence, and *inferiorly* to the neck of the mandible. Its lateral part is thickened to form a triangular band called the **temporo-mandibular ligament.** That ligament is attached by its base to the zygoma and the tubercle of the root of the zygoma, and by its apex to the lateral side of the neck of the mandible.

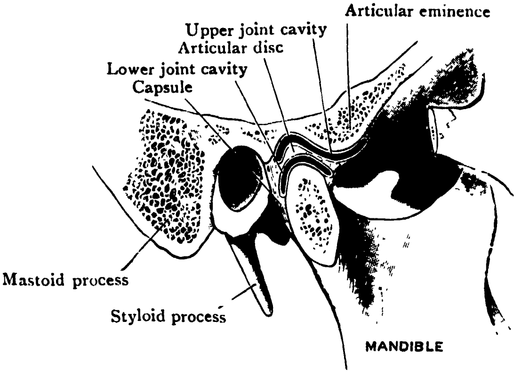


FIG. 66.—Section through the Mandibular Joint.

The **articular disc** is an oval plate of fibro-cartilage whose periphery is fused with the capsular ligament, and it therefore divides the joint-cavity completely into an upper and a lower compartment. The upper is the larger compartment, since the upper articular surface is the wider. To expose the disc, remove the temporo-mandibular ligament. The disc will then be seen to be adapted to the bony surfaces between which it lies: *its upper surface is concavo-convex to fit the articular* eminence and fossa; its lower surface is concave to fit the head of the mandible (Fig. 66). Its centre is thin, and, occasionally, is perforated.

The **synovial membrane** is in two separate parts. It lines the capsular ligament around each chamber, *and is reflected* on to the disc to cover its peripheral part.

The only ligaments proper to the joint are the capsular and temporo-mandibular. Two other ligaments—the spheno-mandibular and stylo-mandibular—are described with the joint because they connect the mandible with the cranium; but they are not closely related to the joint, and add but little to its strength. For that matter, the joint does not rely on any of its ligaments: it is chiefly the muscles of mastication that keep the mandible in its place.

The stylo-mandibular ligament is described on p. 162.

The **spheno-mandibular ligament** is a long, membranous ribbon that extends from the spine of the sphenoid to the lingula and lower margin of the mandibular foramen. Its upper part is hidden by the lateral pterygoid muscle, and is separated by fat from the side of the uppermost part of the pharynx; its lower part lies on the medial pterygoid, and is pierced by the mylo-hyoid nerve and vessels. Laterally, it is separated from the mandibular joint and the mandible by the auriculo-temporal nerve, the lateral pterygoid muscle, the maxillary vessels, and the inferior dental nerve and vessels, and, sometimes, by a process of the parotid gland that lies alongside the maxillary artery.

Movements.—The movements of the mandible at the joint are the following:—(1) depression; (2) elevation; (3) protraction; (4) retraction; (5) side to side or chewing movements.

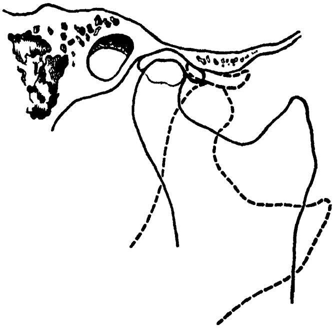


FIG. 67.—Diagram of the different positions occupied by the head of the mandible and the articular disc as the mouth is opened and closed.

When the mandible is *depressed*, the articular disc and the head of the mandible move forwards in the articular fossa, and the head finally takes up a position below the articular eminence. The forward gliding of the disc and head in the upper compartment of the joint is accompanied by another movement in the lower compartment—a rotation of the head of the mandible on the lower surface of the articular disc. *Elevation* of the mandible or closure of the mouth is brought about by a reverse series of changes in both compartments of the joint. There is some doubt about the position of the transverse axis around which the movements of elevation and depression take place, but it is generally supposed to be situated at the level of the mandibular foramen. The movements are therefore least at that level, and consequently the inferior dental vessels and nerves are not unduly stretched when the mouth is opened and shut. In *protraction* and *retraction* the movement is confined chiefly to the upper compartment of the joint, and the head of the mandible, with the articular disc, glides forwards and backwards on the temporal articular surface. In the *chewing movements* of the jaw, the mandible is carried alternately from one to the other side.

The muscles chiefly engaged in producing these movements are the following: (1) *depressors*—the platysma, the mylo-hyoid, and the anterior belly of the digastric; (2) *elevators*—the temporal, masseter, and medial pterygoid; (3) *protractors*—the lateral pterygoid, and to some extent the medial pterygoid and the superficial fibres of the masseter; (4) *retractors*—the posterior fibres of the temporal and the deep fibres of the masseter; (5) *side to side movement* is produced by the muscles of opposite sides acting alternately.

Deeper Contents of Infratemporal Fossa.—The dissectors will now display the structures that lie more deeply. They are:—the middle meningeal artery and some smaller arteries; the mandibular nerve and the proximal parts of its branches; the chorda tympani nerve; the otic ganglion; the tensor palati; and a portion of the maxillary nerve and two of its branches.

> ***Dissection.***—**Disarticulate the head of the mandible and detach the articular disc with it. Take care not to injure the auriculo-temporal nerve, which lies close to the medial side and the back of the joint. When the disarticulation is complete, draw the lateral pterygoid muscle forwards by gently pushing the head of the mandible under the maxillary artery. Then, clear away the fatty areolar tissue that lies medial to the muscle, and expose the middle meningeal artery and the mandibular nerve and its branches.**
>
> **Follow the *middle meningeal artery* upwards to the foramen spinosum. If the subject is well injected, small arteries may be found ascending to the squamo-tympanic fissure and foramen ovale.**
>
> **As the meningeal artery is cleaned, the *auriculo-temporal nerve* will be found, for its two roots embrace the artery. Trace the nerve backwards towards the ear and forwards to its origin from the *mandibular nerve*. Secure each of the branches of the mandibular nerve and clean them in turn. Pull the lingual nerve forwards, and find the *chorda tympani*, which joins its posterior border.**

Middle Meningeal Artery.—This branch of the maxillary artery arises at the lower border of the lateral pterygoid muscle, and ascends to enter the skull through the foramen spinosum. In its ascent, it lies in the fat on the medial side of the lateral pterygoid muscle, and is embraced by the two roots of the auriculo-temporal nerve. It is postero-lateral to the mandibular nerve and is fairly closely related to the pharynx, as it lies on the lateral surface of the tensor palati muscle, which separates it from the pharyngo-tympanic (auditory) tube. Its position and branches inside the skull are described on p. 118.

The *accessory meningeal artery* and the *anterior tympanic artery* arise from the middle meningeal or directly from the maxillary. The *accessory meningeal* inclines forwards and upwards, and enters the cranial cavity through the foramen ovale; the *tympanic* runs upwards and backwards, and reaches the tympanum by passing through the squamo-tympanic fissure.

Mandibular Nerve.—The mandibular branch of the trigeminal nerve arises, within the cranium, from the trigeminal ganglion, and enters the infratemporal fossa through the foramen ovale. Until it leaves the skull it is composed (like the ophthalmic and maxillary branches of trigeminal) wholly of sensory fibres. But, as it descends through the foramen ovale, it is joined by the motor root of the trigeminal nerve; and, below the skull, it is therefore a mixed nerve.

Immediately after its exit from the skull, the mandibular nerve gives off the nervus spinosus and the nerve to the medial pterygoid muscle, and, at a slightly lower level, it divides into an anterior division and a posterior division.

The *undivided trunk* lies immediately below the skull, on the medial side of the lateral pterygoid, behind the medial pterygoid, on the lateral side of the pharynx, where the tensor palati separates it from the pharyngo-tympanic tube; the middle meningeal artery is a little behind it.

The *anterior division* is composed chiefly of motor fibres. It divides almost at once into the deep temporal nerves, the nerves to the masseter and lateral pterygoid, and the buccal nerve; all its sensory fibres pass into the buccal nerve.

The *posterior division* gives off the two roots of the auriculo-temporal nerve and then divides into the lingual and the inferior dental. The only motor fibres in it are those that form the mylo-hyoid branch of the inferior dental.

The **nervus spinosus** is a very slender branch which enters the cranium by accompanying the middle meningeal artery through the foramen spinosum. It supplies the dura mater, and sends a filament into the middle ear.

The **nerve to the medial pterygoid** passes forwards, disappears under cover of the posterior border of the upper end of the medial pterygoid muscle and then enters the uscle. The *otic ganglion* is in close relation to its com-encement.

The **buccal nerve** is the largest branch of the anterior vision. It passes laterally between the two heads of the teral pterygoid muscle, and then downwards and forwards 'er the lower head, under cover of the temporalis and

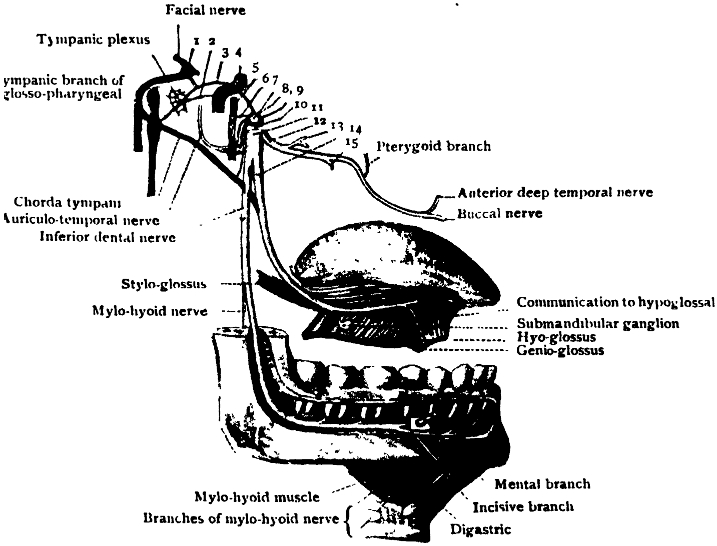


FIG. 68.—Diagram of Mandibular Nerve (A. M. Paterson). The tongue has been separated and raised above the level of the body of the mandible.

1. Ganglion of facial nerve
2. Carotico-tympanic nerve
3. Lesser superficial petrosal
4. Internal carotid artery
5. Middle meningeal artery
6. Symp. root of otic ganglion
7. Otic ganglion
8. Nerve to tensor tympani
9. Nerve to tensor palati
10. Nerve to medial pterygoid
11. Mandibular nerve trunk
12. Anterior division
13. Deep temporal
14. Lingual nerve
15. Masseteric branch

asseter, to reach the surface of the buccinator muscle near ; lower border. After dividing and forming a plexus with e buccal branches of the facial nerve, it supplies the skin ıd the mucous membrane of the soft part of the cheek. In ; course downwards, it is opposite the anterior margin of e ramus of the mandible in close relation to the deep surface the temporal muscle—parallel with its tendinous fasciculi ıd within its sheath. It is often in a groove flush with ıe deep surface of the muscle, and may even be within its ıbstance.

The **nerve to the lateral pterygoid** arises in common with the buccal nerve and leaves it to enter the muscle as it passes between its heads.

The **deep temporal nerves**—an anterior and a posterior—pass laterally above the lateral pterygoid and then upwards into the temporal fossa to sink into the temporal muscle; in their course to the muscle they cling closely to the bone. A deep temporal branch often arises from the buccal nerve after it has appeared between the heads of the lateral pterygoid. This branch passes upwards over the upper head of the lateral pterygoid to reach the temporal muscle; and it may replace the anterior deep temporal.

The **nerve to the masseter** arises in common with the posterior deep temporal. It passes laterally above the lateral pterygoid muscle and through the mandibular notch close behind the temporal muscle, and sinks into the upper part of the deep surface of the masseter near its posterior border. Before it reaches the masseter, it gives one or two twigs to the capsule of the mandibular joint.

The **auriculo-temporal nerve** springs by two roots from the posterior division of the mandibular nerve, under cover of the lateral pterygoid. The two roots are composed of sensory fibres and each receives a communication from the otic ganglion, by means of which it is brought, indirectly, into association with the glosso-pharyngeal nerve. The roots embrace the middle meningeal artery, and unite behind it to form a stem which runs backwards between the neck of the mandible and the spheno-mandibular ligament. At the interval between the ear and mandible it turns upwards in relation to the antero-medial surface of the parotid gland, crosses the posterior root of the zygoma immediately behind the superficial temporal artery, and enters the temple, where it breaks up into terminal branches (Fig. 59).

Its branches are:—(1) A few slender filaments to the posterior part of the capsule of the mandibular joint. (2) One or two thick branches which enter the parotid gland to supply the gland and to join the upper branches of the facial nerve. (3) Auricular branches. (4) Terminal filaments to the skin over the temporal region.

The *auricular* branches are usually *two* to the skin of the upper part of the lateral surface of the auricle, and *two* which pass between the bony and cartilaginous parts of the external meatus to supply the skin that lines the upper part of its inferior.

The **inferior dental nerve** (N. alveolaris inferior) is the largest branch of the posterior division of the mandibular nerve. It emerges from under cover of the lateral pterygoid at the lower border of the muscle, passes downwards on the lateral surface of the spheno-mandibular ligament and medial pterygoid muscle, and enters the mandibular foramen. The inferior dental branch of the maxillary artery runs downwards behind it, and the lingual nerve is in front of it, on a rather deeper plane. It runs downwards and forwards in the canal in the body of the mandible, gives off branches to the teeth of the lower jaw, and sends the *mental nerve* out through the mental foramen to supply the skin of the chin and the skin and mucous membrane of the lower lip.

The inferior dental nerve is a sensory nerve, but a few motor fibres are contained within its sheath, and separate off as the mylo-hyoid nerve (Figs. 65, 71).

The *mylo-hyoid nerve* arises near the mandibular foramen. Accompanied by the vessels of the same name, it pierces the spheno-mandibular ligament and proceeds downwards and forwards, in a groove on the medial surface of the mandible, to the digastric triangle. A narrow prolongation of the spheno-mandibular ligament bridges over the groove and holds the nerve and vessels in position. The vessels reach little beyond this groove, but the nerve passes into the digastric triangle (p. 155), where it is accompanied by the submental artery, and breaks up into numerous branches for the supply of the mylo-hyoid and the anterior belly of the digastric (Fig. 71).

The **lingual nerve** is almost as thick as the inferior dental. It is entirely sensory and is distributed to the mucous membrane of the anterior two-thirds of the tongue. In the first part of its course, like the other branches of the mandibular nerve, it is medial to the lateral pterygoid muscle. As it descends it appears at the lower border of the muscle in front of the inferior dental nerve. It then proceeds downwards and forwards, between the medial pterygoid muscle and the mandible, and enters the submandibular region, where it will afterwards be traced to the tongue. It gives off no branches in the infratemporal region, but, while still under cover of the lateral pterygoid, it is joined by the *chorda tympani* branch of the facial nerve. Not infrequently, also, a communicating twig passes between it and the inferior dental nerve.

Chorda Tympani.—This slender nerve arises from the facial in the temporal bone behind the middle ear or tympanic cavity. It gains the infratemporal region by traversing the tympanic cavity and appearing through the medial part of the squamo-tympanic fissure. From that point, it runs downwards and forwards, grooving the medial side of the spine of the sphenoid, and passes medial to the middle meningeal artery to join the lingual nerve at an acute angle a little below its origin. It receives a slender filament from the otic ganglion.

The otic ganglion and its connexions should now be displayed, and afterwards the tensor palati muscle should be cleaned from its origin downwards to the pterygoid hamulus.

Dissection.—Twist the mandibular nerve round, look for the _otic ganglion_ on its deep surface, define the ganglion and try to secure some of its roots and branches. (It may be necessary to divide the mandibular nerve and evert it.)

Clean the part of the _tensor palati_ muscle that is medial to the meningeal artery and mandibular nerve. To expose and clean the rest of it, remove the upper part of the medial pterygoid muscle, and, if necessary, snip off part of the lateral pterygoid plate with bone-forceps.

Otic Ganglion.—The otic ganglion is a minute body, not easily found. It lies between the mandibular nerve and the tensor palati, immediately below the foramen ovale, on the origin of the nerve to the medial pterygoid (Fig. 68).

The otic ganglion receives motor, sympathetic and secretory (parasympathetic) roots. The *motor root* is supplied by the nerve to the medial pterygoid muscle. The *sympathetic root* comes from the plexus around the middle meningeal artery. The *secretory* or *parasympathetic root* is the lesser superficial petrosal nerve, which enters the ganglion and conveys *secretory* and possibly *sensory* fibres to it from the facial and glosso-pharyngeal nerves; and it may be joined by some sensory fibres from the auriculo-temporal nerve.

The following *branches* proceed from the otic ganglion: (1) A twig which passes downwards and forwards to the tensor palati, and (2) a twig which proceeds upwards and backwards to supply the tensor tympani; their fibres come from the motor root of the trigeminal nerve and pass without relay through the ganglion. (3) One or more filaments to one or both of the roots of the auriculo-temporal nerve; they come through the lesser superficial petrosal nerve from the glosso-pharyngeal and possibly the facial, and convey parasympathetic secretory fibres to the parotid gland; and they are the only fibres relayed in the ganglion. (4) Communicating filaments to the chorda tympani and to the nerve of the pterygoid canal.

Tensor Palati.—The tensor of the soft palate is a thin, flat, triangular muscle that lies very deeply in the infratemporal fossa, hidden under cover of the medial pterygoid muscle, the mandibular nerve and the middle meningeal vessels. It is, in fact, a muscle of the side wall of the uppermost part of the pharynx and is closely applied to the anterolateral surface of the pharyngo-tympanic (auditory) tube.

The tensor palati arises from the floor of the scaphoid fossa, from the spine of the sphenoid, and, between these bony origins, from the lateral surface of the pharyngo-tympanic (auditory) tube. Its fibres converge on the lower end of the medial pterygoid plate (Fig. 54) and end in a slender tendon which turns horizontally, in a groove on the lower surface of the root of the hamulus, into the soft palate, to be inserted into the fibrous membrane in the substance of the soft palate and into the palatine crest. It is supplied by the mandibular nerve through the otic ganglion.

A small portion of the *maxillary nerve* and two of its branches have been found in the infratemporal fossa already. The nerve will be fully dissected at a later stage, but its course and most of its branches should be studied now.

> ***Dissection.***—**Take the stitches out of the flaps of the scalp, turn the flaps aside and remove the skull-cap and the tow in order to expose the orbit again.**
>
> **Push the contents of the orbit upwards and medially out of the way, or, if they are too unyielding, remove them. Find the *zygomatic nerve* in or near the angle between the floor and the lateral wall of the orbit, and trace the nerve forwards till it enters the bone.**
>
> **Then, strip the periosteum off the floor ; identify the infra-orbital groove ; and trace the *infra-orbital nerve* forwards into the infra-orbital canal. Chip off the roof of the canal with bone-forceps, lift the nerve and find its dental branch.**

Maxillary Nerve.—Obtain the base of a skull and identify the *foramen rotundum*, the *pterygo-palatine fossa*, the *inferior orbital fissure*, the *infra-orbital groove*, *canal* and *foramen*. Push a match out of the cranial cavity through the foramen rotundum and onwards towards the beginning of the infra-orbital groove : it will roughly represent the maxillary nerve.

The maxillary nerve is the second of the three divisions of the trigeminal nerve. It arises from the trigeminal ganglion (p. 112), runs forwards on the side of the body of the sphenoid, between the two layers of the dura mater, along the lower border of the cavernous sinus, and leaves the cranial cavity by passing through the foramen rotundum. It then crosses the upper part of the pterygo-palatine fossa and curves laterally through the pterygo-maxillary fissure to enter the infratemporal fossa. It leaves that fossa almost at once and passes through the inferior orbital fissure to become the infra-orbital nerve.

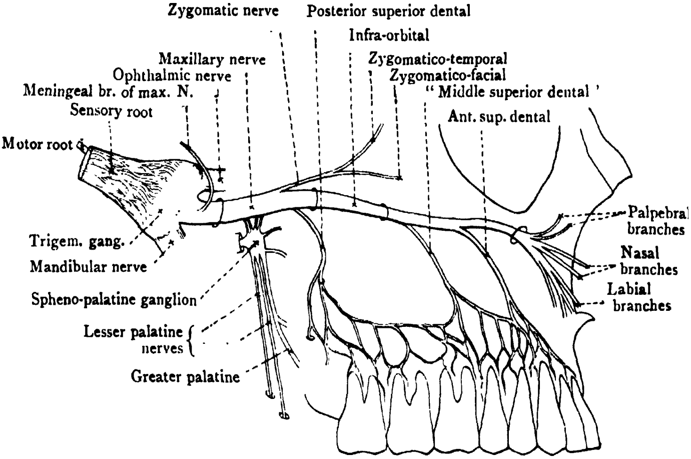


FIG. 69.—Diagram of the Maxillary Nerve.

The branches of the maxillary nerve are:—

1. A *meningeal branch* arises near its origin (p. 114).
2. Two *ganglionic branches* arise in the pterygo-palatine fossa. They join the spheno-palatine ganglion and will be examined with it (p. 305).

3 and 4. The *posterior superior dental* nerve and the *zygomatic* nerve arise during the very short sojourn of the maxillary nerve in the infratemporal fossa.

5. The *infra-orbital* nerve—which is the continuation of the maxillary nerve.

The **posterior superior dental nerve** divides into two branches which run downwards over the back of the maxilla. They supply filaments to the gum and to the mucous membrane of the cheek, and then, with dental branches of the maxillary artery, enter canals in the bone by which they reach the molar and premolar teeth. The canal for the posterior or main branch curves forwards to run a horizontal course between the zygomatic process and the tooth-sockets, and can be traced as far as the canine socket (Wood Jones). The anterior branch runs its course at a higher level, and ends by joining a plexus formed in the bone by the main branch and the anterior superior dental nerve. It has been described as a *middle superior dental nerve* (for the supply of the premolar teeth), but it seldom arises independently from the infra-orbital nerve as shown in Fig. 69.

The **zygomatic nerve** is small. It enters the orbit through the anterior part of the inferior orbital fissure, pierces the periosteum and almost immediately divides into two terminal branches — zygomatico-temporal and zygomatico-facial — which run forwards between the periosteum and the bone of the lateral wall of the orbit, and then perforate the bone to reach the skin of the temple and face (pp. 17, 31).

The **infra-orbital nerve** is the continuation of the maxillary nerve, and begins at the middle of the inferior orbital fissure. It enters the infra-orbital groove at once, accompanied by the infra-orbital branch of the maxillary artery and its companion vein. It runs forwards in the floor of the orbit (which is also the roof of the maxillary sinus), traversing the infra-orbital groove and canal. It emerges into the face through the infra-orbital foramen, under cover of the levator labii superioris and orbicularis oculi, and ends at once by dividing into the *labial*, *nasal* and *palpebral* branches described on p. 31.

About the middle of the floor of the orbit, it gives off a thick branch named the *anterior superior dental nerve*, which, with a branch of the infra-orbital artery, is conveyed to the canine and incisor teeth by a remarkably sinuous canal (Wood Jones).

The canal first runs forwards in the roof of the maxillary sinus a little lateral to the infra-orbital canal; secondly, it curves medially in the anterior wall of the sinus to reach the side of the nose; thirdly, it descends towards the teeth; and, finally, it curves medially again to open into the nose close to the septum at the root of the anterior nasal spine. In the third and fourth parts of its course, the nerve gives branches not only to the teeth but also to the mucous membrane of the antero-inferior part of the nose.

The superior dental nerves give twigs to the mucous lining of the maxillary sinus; and, from the plexus formed by their terminal branches, the gum as well as the teeth is supplied.

The maxillary sinus is one of the most important of the air-sinuses; and this is the best time to explore and study it.

Dissection.—**Open the *maxillary sinus* by sawing through the zygomatic process of the maxilla, or by removing the postero-lateral part of the maxilla with bone-forceps. With a seeker, explore the sinus, and find the aperture by which it communicates with the cavity of the nose.**

Maxillary Sinus.—This is the largest of the air-sinuses. It occupies the whole of the body of the maxilla and may extend into its zygomatic process. It is below the orbit, in front of the pterygo-palatine and infratemporal fossæ, lateral to the lower part of the cavity of the nose, and above the molar and premolar teeth.

The lowest part of its floor is opposite the second premolar and first molar, and is nearly half an inch below the level of the floor of the nose. The opening out of the sinus leads into the part of the nasal cavity called the middle meatus. The opening is in the *upper* part of the medial wall of the sinus—a position highly unfavourable for the escape of liquids that may collect in the sinus. The infra-orbital groove and canal, containing the infra-orbital vessels and nerve, run forwards in the roof of the sinus, and as the canal bends downwards towards the infra-orbital foramen it produces a marked ridge in the angle between the roof and anterior wall of the sinus. The posterior superior dental nerve and vessels descend in the lower part of the posterior and lateral walls of the sinus; the anterior superior dental nerve and vessels are in the roof and anterior wall. Occasionally some of the canals in which the nerves run are partly defective; the nerves then lie between the bones and the mucous lining, and the sensation of toothache may arise from affection of the nerves during inflammation of the lining of the sinus. As in the other air-sinuses, the mucous membrane is covered with ciliated epithelium; the action of the cilia promotes the movement of the mucus towards the opening into the nose.

The dissectors, having explored the interior of the maxilla, will replace the skull-cap and the flaps of the scalp; they will then cut into the mandible and examine its interior; when that has been done they will pass on to the dissection of the submandibular region.

Dissection.—**To open up the mandibular canal, remove the outer table of the mandible with a Hey's saw, chisel, and bone-forceps.**

Structures within the Mandibular Canal.—The mandibular canal is traversed by the *inferior dental vessels and nerve, which give off twigs to the roots of the molar and premolar teeth. Both the nerve and the artery terminate by* dividing into a mental and an incisor branch.

The *mental nerve and artery* appear on the face through the mental foramen, and have been examined already (pp. 27, 31); the *incisor nerve and artery* pass forwards to the symphysis and send up twigs to the canine and incisor teeth. The vessel anastomoses, in the bone, with its fellow of the other side.

SUBMANDIBULAR REGION

The submandibular region is the region under cover of the body of the mandible, and between the mandible and the hyoid bone. Its superficial part includes the submental and digastric triangles, which have been dissected already. It is now necessary to carry the dissection to a deeper plane, in order to expose a number of parts in connexion with the tongue and floor of the mouth. The structures to be displayed are :—

1. Submandibular gland and its duct.
2. Sublingual gland.
3. Side of tongue, and mucous membrane of mouth.
4. Muscles.
    - Mylo-hyoid.
    - Digastric.
    - Stylo-hyoid.
    - Stylo-glossus.
    - Genio-hyoid.
    - Genio-glossus.
    - Hyo-glossus.
5. Nerves.
    - Mylo-hyoid.
    - Hypoglossal.
    - Lingual.
    - Glosso-pharyngeal.
6. Submandibular ganglion.
7. Lingual artery and veins.
8. Part of the facial artery.
9. Stylo-hyoid ligament.

Dissection.—To prepare the part for dissection, throw back the head to its full extent, and turn it slightly to the opposite side. Divide the facial artery and the anterior facial vein at the lower border of the mandible, and detach the anterior belly of the digastric from the mandible. Then, tilt the mandible upwards as far as possible, and fix it with hooks. Or, if the parts are too unyielding for the mandible to be turned upwards sufficiently, divide it with the saw a little lateral to the median plane, and then turn it upwards and fix it ; but this should not be done unless the rigidity of the soft parts makes it really necessary.

Complete the cleaning of the *posterior belly of the digastric* and the *stylo-hyoid* which was done partly when the digastric triangle was dissected.

Digastric Muscle (Figs. 70, 71).—The **anterior belly** of the digastric springs from the lower border of the mandible, close to the symphysis; the fibres of the medial margins of the right and left muscles often decussate below the chin. The **posterior belly** arises from the floor of the mastoid notch on the medial side of the mastoid process. The two bellies converge upon the upper border of the hyoid bone, where they are united by an **intermediate tendon**, which is attached to the hyoid bone, at the junction of the body with the greater cornu, by a strong loop of fibrous tissue developed from the deep cervical fascia ; the loop is a pulley through which the tendon moves backwards and forwards. Behind the loop, the intermediate tendon passes through the lower end of the stylo-hyoid muscle.

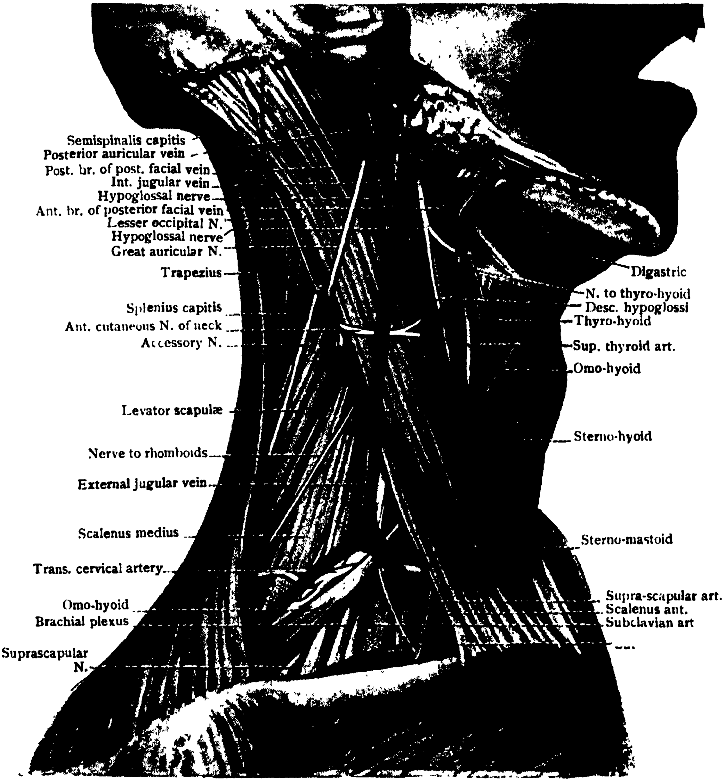


FIG. 70.—Triangles of the Neck seen from the side. In the digastric triangle, note the anterior belly of the digastric muscle, and portions of the posterior belly, stylo-hyoid and submandibular gland.

The posterior belly is supplied by the *facial nerve*, and the anterior belly is supplied by the *mylo-hyoid nerve*.

If the digastric acts from its posterior attachment it depresses the mandible. If the mandible is fixed and the digastric acts from its anterior attachment it helps to tilt the head backwards. If both the bellies act simultaneously the hyoid bone is raised.

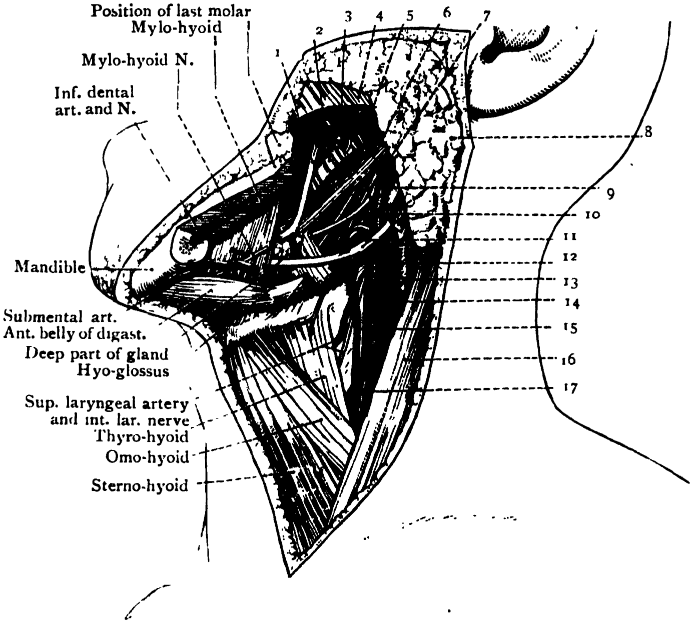


FIG. 71.—Deep Dissection of Infratemporal and Submandibular Regions.

1. Lingual nerve.
2. Medial pterygoid muscle.
3. Inferior dental nerve, and mylo-hyoid branch with inferior dental artery.
4. Masseter muscle.
5. Mandible.
6. Stylo-glossus muscle.
7. Stylo-pharyngeus muscle and glosso-pharyngeal nerve.
8. Parotid gland.
9. Stylo-hyoid and digastric muscles.
10. Facial artery.
11. Lingual artery.
12. Internal carotid artery and descendens hypoglossi nerve.
13. Internal jugular vein.
14. External carotid artery.
15. Superior thyroid artery.
16. Sterno-mastoid muscle.
17. External laryngeal nerve.

Relations—The anterior belly is covered with the skin, superficial fascia and the platysma, and the deep fascia, and is overlapped by the submandibular gland; its deep surface is in contact with the mylo-hyoid muscle.

The relations of the posterior belly are more numerous and important. Posteriorly, it is covered by the mastoid process and the attachments of the sterno-mastoid and splenius capitis muscles. Between the mastoid process and the angle of the mandible, it is covered by the parotid gland; next, it is covered by the angle of the mandible and the insertion of the medial pterygoid muscle. As it lies in the anterior triangle, it is covered with the skin, the superficial fascia and platysma, and the deep fascia; it is crossed by the anterior facial vein, and is overlapped by the submandibular gland.

It is superficial to the internal jugular vein, the internal and the external carotid arteries, the facial artery, the middle constrictor of the pharynx, and the lower and posterior part of the hyo-glossus muscle. The accessory nerve passes backwards and downwards between it and the internal jugular vein, and the occipital artery passes upwards and backwards under cover of its lower border. The hypoglossal nerve descends vertically across its deep surface in the angle between the internal jugular vein and the internal carotid artery; and the glosso-pharyngeal nerve passes forwards and downwards between it and the internal carotid. The posterior auricular artery runs upwards and backwards along the posterior part of its upper border, and the stylo-hyoid muscle descends along the same border (Figs. 59, 134).

Stylo-Hyoid Muscle.—This is a small muscular bundle which springs from the middle of the styloid process, and descends along the upper border of the posterior belly of the digastric. It divides below into two slips which embrace the intermediate tendon of the digastric and are then inserted into the hyoid bone at the junction of the greater cornu with the body. It is supplied by the *facial nerve*. It raises the hyoid bone and draws it backwards during swallowing.

Dissection.—Turn the anterior part of the submandibular gland backwards, and clean the posterior part of the mylo-hyoid muscle. Note that a process of the gland, called its *deep part*, springs from its medial surface and passes forwards, deep to the mylo-hyoid. Carefully dissect the facial artery out of the deep sulcus in the posterior part of the gland; secure the branches which arise from it in this region, and trace them as far as possible; and identify the *mylo-hyoid nerve* again (p. 154).

Displace the posterior part of the gland forwards and expose the *hypoglossal nerve* on the hyo-glossus muscle immediately above the greater cornu of the hyoid bone, and, at a higher level, the *lingual nerve*; find the *submandibular ganglion*, which

hangs from the lingual nerve, and the *submandibular duct*, which passes forwards with the deep part of the gland.

Submandibular Gland (Gl. Submaxillaris).—The submandibular is one of the large salivary glands, and is about half the size of the parotid gland. It lies partly between the mandible and the hyoid bone, and partly under cover of the mandible, wedged in between the mandible and the mylo-hyoid muscle. Superiorly, it reaches the mylo-hyoid line, and is related to the mucous membrane of the mouth below the posterior part of that line. Inferiorly, it may be limited by the bellies of the digastric, or may overlap them and reach the hyoid bone. *Posteriorly*, it reaches the angle of the mandible, and is separated from the parotid gland only by fascia. *Anteriorly*, it reaches as far as the line of the *mental foramen*.

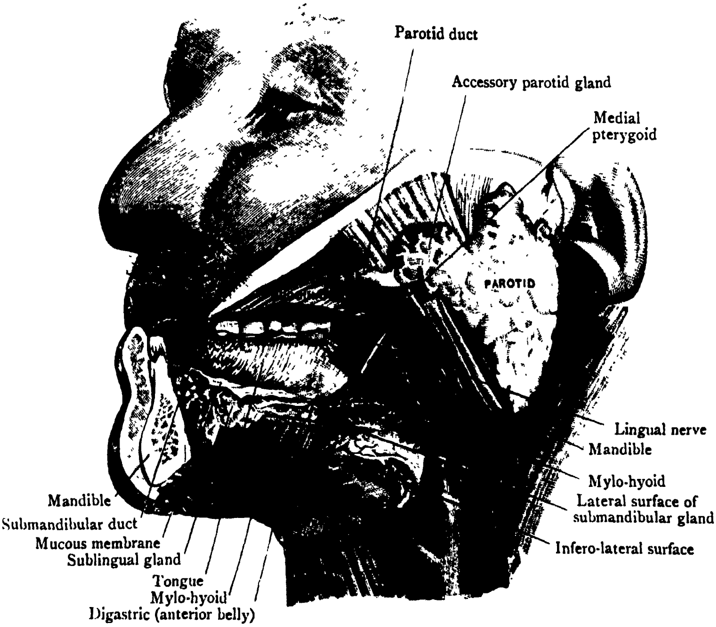


FIG. 72.—Dissection of Parotid, Submandibular and Sublingual Glands.

The gland is partly enclosed in a sheath of cervical fascia.

The first layer of fascia, extending from the hyoid bone to the lower border of the mandible, covers the part of the gland that lies below the mandible; while the deep or medial surface of the gland is related to the sheet of fascia that extends from the hyoid bone to the mylo-hyoid line, covering the mylo-hyoid and hyo-glossus muscles.

Surfaces and Relations.—The gland has three surfaces—medial, lateral and infero-lateral.

The *infero-lateral surface* is the one seen in the neck. It is covered with (1) skin, (2) superficial fascia containing platysma and the cervical branch of the facial nerve, and (3) deep fascia; under cover of the deep fascia, it is crossed by the anterior facial vein. Some of the submandibular lymph-glands are embedded in this surface, but most of them lie in the groove between it and the mandible. The facial artery, which first ascends in a deep groove in the posterior end of the gland, and then passes downwards and forwards between the medial pterygoid muscle and the gland, appears between the mandible and the infero-lateral surface; its submental branch runs forwards at first between the gland and the mandible and then gains the medial side of the gland.

The *lateral surface* is related to the medial pterygoid muscle and the facial artery, and, farther forwards, to the mandible below the mylo-hyoid line. The mylo-hyoid nerve and vessels, in their groove below that line, are related to the upper border of the gland, but, farther forwards, the nerve joins the submental vessels on its medial side.

The *medial surface* is much the largest surface. Inferiorly, it may overlap the bellies of the digastric. Anteriorly, it lies on the mylo-hyoid muscle and nerve and the submental vessels. Farther back, it lies on the hyo-glossus and the structures on that muscle—hypoglossal nerve, submandibular ganglion, and lingual nerve—and the upper part is related to the mucous membrane of the mouth; and, at the posterior end, where it is indented by the facial artery, it is related to the pharynx. The duct of the gland springs from the medial surface, and will be seen when the mylo-hyoid is reflected.

The *deep part* of the gland is a thin, flat, tongue-like process that extends along the duct. It lies between the duct and the mylo-hyoid muscle (Fig. 74).

Nerves and Vessels.—The nerve-supply of the gland is derived from the lingual nerve, the sympathetic plexus on the facial artery and the submandibular ganglion (in which parasympathetic secretory fibres from the chorda tympani are relayed). Its arterial supply consists of small glandular branches from the facial and submental arteries.

Facial Artery (A. Maxillaris Externa).—The facial artery arises, in the carotid triangle, from the front of the external carotid artery immediately above the level of the tip of the greater horn of the hyoid bone; and it runs a very sinuous course. At first, it passes almost vertically upwards under cover of the posterior belly of the digastric, the stylo-hyoid and the angle of the mandible. In this part of its course it lies on the side of the pharynx—first on the middle constrictor and then on the superior constrictor, which separates it from the tonsil. It next hooks forwards above the stylo-hyoid and digastric muscles (Fig. 73), making a deep dent in the posterior end of the submandibular gland to reach its lateral surface, and then runs downwards and forwards between the gland and the mandible to reach the lower border of the bone at the antero-inferior angle of the masseter. There, it pierces the deep fascia, and bends upwards into the face, where it has been dissected already.

The named branches which arise from the facial artery in the neck are:—ascending palatine; tonsillar; glandular; submental.

The *ascending palatine artery* runs upwards on the side of the pharynx deep to the stylo-glossus. At the upper end of the pharynx, it turns over the upper border of the superior constrictor, and descends with the levator palati muscle to the soft palate. Only a small part of it can be seen in this dissection.

The *tonsillar artery* ascends superficial to the stylo-glossus, and pierces the superior constrictor to reach the tonsil.

The *glandular branches* are small twigs that supply the submandibular gland.

The *submental artery* is a branch of some size. It arises as the facial escapes from the groove in the submandibular gland. It runs forwards between the gland and the mandible, and then turns round the upper border of the gland to reach the surface of the mylo-hyoid muscle, where it joins the *mylohyoid nerve*, and ends in small branches to muscles, to the submandibular and sublingual glands and to the skin.

***Dissection.*—Displace the submandibular gland and the submental vessels backwards; cut the mylo-hyoid nerve, and turn the anterior belly of the digastric downwards; then, clean the mylo-hyoid muscle and examine its attachments.**

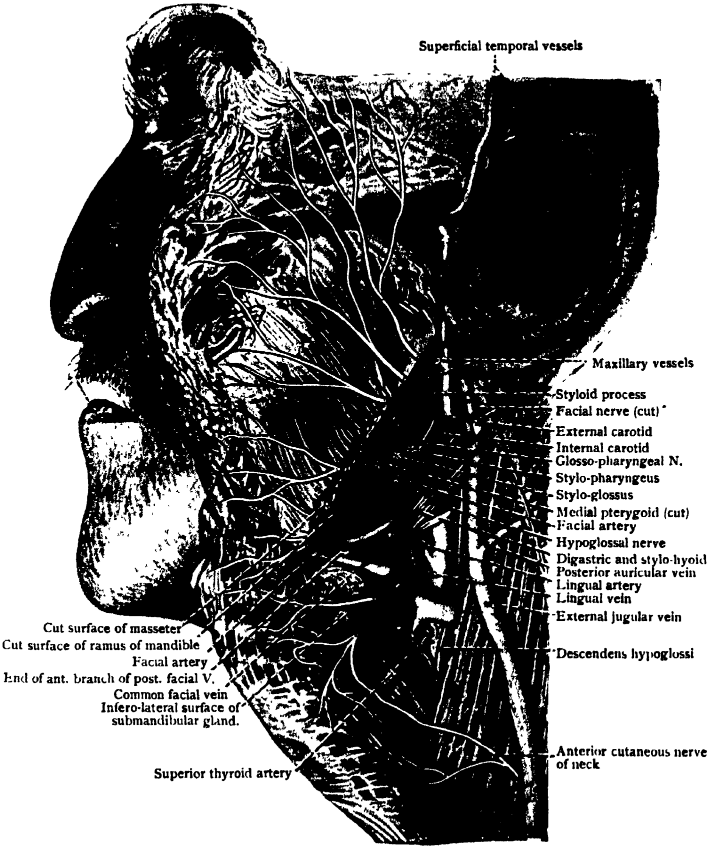


FIG. 73.—Dissection to show the Relations of the External Carotid Artery and the deep part of the Facial Artery. The parotid gland and the posterior part of the ramus of the mandible and the muscles attached to it have been removed. The terminal branches of the facial nerve have been cut and the terminal parts left *in situ.*

In this specimen, the anterior branch of the posterior facial vein was very small, and the posterior branch formed the greater part of the external jugular vein. The lingual vein joined the common facial vein; and the origin of the facial artery was deep to the posterior belly of the digastric muscle.

Mylo-Hyoid Muscle.—The mylo-hyoid is a thin sheet of muscular fibres which arises from the whole length of the mylo-hyoid line. Its fibres are directed downwards, medially and forwards, and present two different modes of insertion. The posterior fibres are inserted into the body of the hyoid bone; they, however, form a comparatively small part of the muscle.

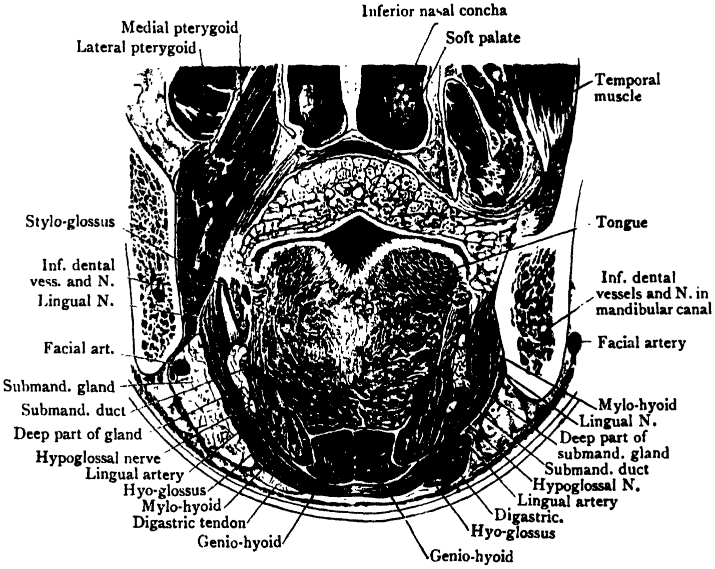


FIG. 74.—Coronal Section through the Tongue and Submandibular Region in a plane behind the molar teeth.

Most of the fibres are inserted into a median fibrous *raphe* which extends between the symphysis of the mandible and the body of the hyoid bone. The two mylo-hyoid muscles, therefore, stretch across from one side of the body of the mandible to the other, above and in front of the hyoid bone, and constitute a floor for the anterior part of the mouth, sometimes termed the *diaphragma oris*; and the mucous membrane clothes the posterior part of the upper surface of the muscle near its origin.

The mylo-hyoid muscle is supplied by the ***mylo-hyoid nerve***. It elevates the hyoid bone, the tongue and the floor of the mouth in the movement of swallowing.

Dissection.—Cut the mylo-hyoid muscle a little below its origin and turn it downwards and forwards, taking care not to injure the mucous membrane of the mouth.

PARTS EXPOSED BY THE REFLEXION OF MYLO-HYOID (Fig. 75).—Part of the tongue and a number of structures associated with it are now brought into view.

First, note the mucous membrane stretching from the tongue to the inner side of the mandible; then, identify the various muscles.

The *hyo-glossus*, a portion of which was previously visible behind the mylo-hyoid, is fully exposed. It is a quadrangular sheet of fleshy fibres which extends from the hyoid bone to the side of the tongue. Mark its position, because all the structures in the region now under consideration have a more or less intimate relationship to it. Thus, posterior and also superficial to its upper part, the *stylo-glossus muscle* will be recognised, whilst the *genio-glossus* and the *genio-hyoid* are in front of it. The genio-hyoid muscle occupies the antero-inferior part of the region; and the anterior part of the genio-glossus is seen in the interval between the genio-hyoid and the hyo-glossus.

On the surface of the hyo-glossus, the lingual and hypoglossal nerves, the connecting loop between them, the deep portion of the submandibular gland, with the duct, and the submandibular ganglion, are to be dissected. The *lingual nerve* occupies the highest level, and passes forwards over the muscle near its insertion into the tongue. The *hypoglossal nerve*, with its *vena comitans* and sometimes another lingual vein, crosses the muscle close to the hyoid bone; and the *submandibular duct* and the *deep part of the gland* occupy an intermediate place. Although the *submandibular ganglion* is very small, its relations are so precise that it is very easily found. Seize the lingual nerve and dissect carefully in the interval between it and the submandibular duct, and you will expose the ganglion and its roots and branches of distribution (Fig. 75).

In front of the hyo-glossus, on the genio-glossus, the *sublingual gland* and its artery of supply will be seen.

If the stylo-hyoid and the posterior belly of the digastric are displaced backwards, certain structures will be seen passing under cover of the posterior margin of the hyo-glossus muscle. They are :—(1) the glosso-pharyngeal nerve immediately below the stylo-glossus muscle ; (2) the stylo-hyoid ligament, a little lower down ; and (3) the lingual artery, close to the hyoid bone (Fig. 75).

Dissection.—Define and clean the structures on the surface of the hyo-glossus and genio-glossus. Trace the *stylo-glossus* backwards to its origin from the styloid process, taking care of the branches of the facial artery that ascend in relation to it. Identify the *stylo-pharyngeus*—a slender muscle which lies below and behind the stylo-glossus. Secure the *glosso-pharyngeal nerve*, which curves forwards across the stylo-pharyngeus, and trace the nerve forwards till it disappears under the hyo-glossus (Fig. 75). At the same time, find and trace the *stylo-hyoid ligament*. Define the upper edge of the *middle constrictor*, which is superficial to the stylo-pharyngeus ; and then define the antero-inferior part of the *superior constrictor*, which is on a deeper plane and higher up.

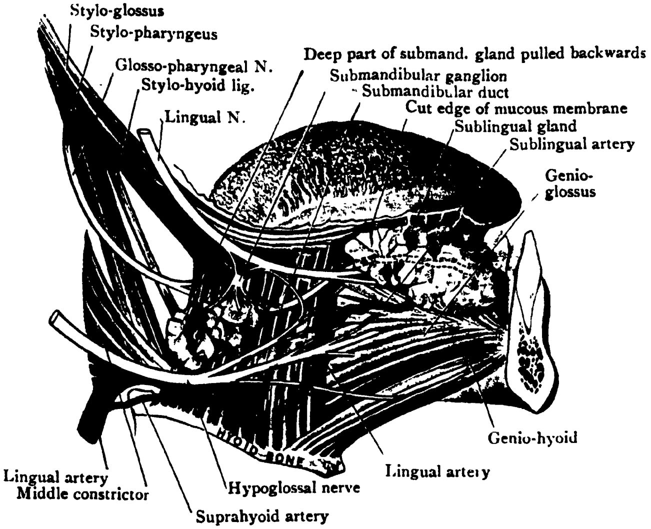


FIG. 75.—Dissection of Submandibular Region.

Hyo-Glossus.—The hyo-glossus is a quadrate, flat muscle which arises from the whole length of the greater cornu of the hyoid bone and also from its body. Its fibres pass upwards to be inserted into the posterior half or more of the side of the tongue, medial to the stylo-glossus.

It is supplied by the *hypoglossal nerve.* It helps to depress the tongue and enlarge the cavity of the mouth in sucking.

Stylo-Glossus.—This muscle is an elongated fleshy slip which takes origin from the styloid process near its tip, and from the adjoining part of the stylo-hyoid ligament. It passes downwards and forwards, and is inserted into the whole length of the side of the tongue, decussating with the fasciculi of the hyo-glossus muscle. It pulls the tongue backwards and upwards during swallowing; and its nerve of supply is derived from the *hypoglossal nerve.*

Genio-Hyoideus.—The genio-hyoid is placed close to the median plane, in contact with its fellow. It is a short muscle which arises from the lower genial tubercle, and extends downwards and backwards to gain insertion into the body of the hyoid bone. It is supplied by the *hypoglossal nerve.* It pulls the hyoid bone upwards and forwards.

Submandibular Duct (Ductus Submaxillaris).—The duct of the submandibular gland emerges from the medial surface of the gland, and proceeds forwards and upwards to gain the floor of the mouth, where it opens, by a small orifice, on the summit of a little elevation called the *sublingual papilla* placed at the anterior end of a ridge of mucous membrane called the *sublingual fold.* These structures can be seen in the floor of the living mouth, and can be felt by the tip of one's own tongue.

The duct lies at first on the hyo-glossus under cover of the mylo-hyoid (from which it is separated by the deep part of the gland), with the lingual nerve above it and the hypoglossal nerve below. It next passes on to the genio-glossus, where the sublingual gland separates it from the mylo-hyoid, and the lingual nerve twists round it—crossing it superficially from above downwards at the anterior border of the hyo-glossus, and then passing upwards deep to it.

The wall of the duct is much thinner than that of the parotid duct. Make a small opening in it, and pass a fine probe or bristle along it into the mouth.

Sublingual Gland.—The sublingual gland lies in the floor of the mouth, and is the smallest of the three large salivary glands. It is almond-shaped—about an inch and a half long—and its relations are very definite. Its *upper border* is covered with the mucous membrane of the floor of the mouth, and raises it up as the ridge called the sublingual fold (Figs. 76, 105). *Medially*, it rests on the genio-glossus; and the submandibular duct and lingual nerve lie between it and the muscle. *Laterally*, it lies against the deep surface of the mandible immediately lateral to the symphysis and above the mylo-hyoid line.. *Below*, it is supported by the mylo-hyoid muscle. Its anterior extremity reaches the median plane above the anterior border of the genio-glossus, and is in contact with its fellow of the opposite side.

Ducts.—Numerous small ducts (eight to twenty) proceed from the gland, and open into the mouth on the summit of the sublingual fold.

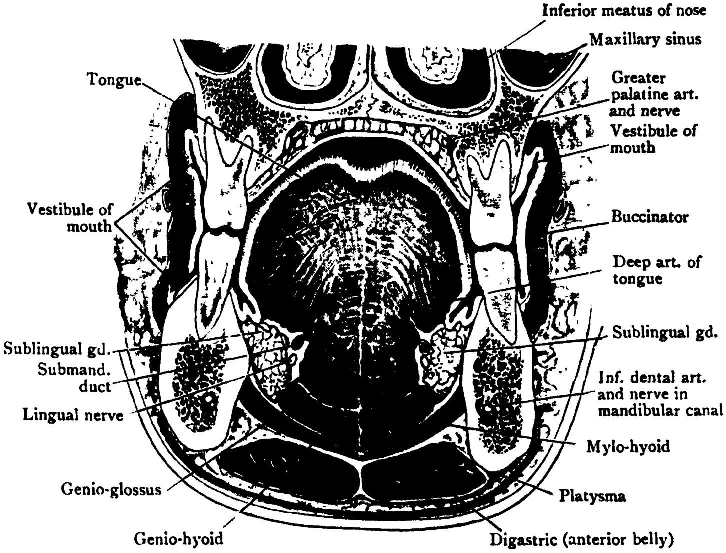


FIG. 76.—Coronal Section through the Closed Mouth in the plane of the second molar teeth.

Vessels and Nerves.—The sublingual branch of the lingual artery is the chief arterial supply, but small branches of the submental artery pierce the mylo-hyoid muscle to reach it.

Branches of the lingual nerve supply it; they contain sympathetic fibres and postganglionic parasympathetic fibres which come into the lingual nerve from the submandibular ganglion.

Lingual Nerve.—In the dissection of the infratemporal fossa, the lingual nerve was seen passing downwards between the ramus of the mandible and the medial pterygoid muscle.

As it descends, it inclines forwards, and, after passing over the superior constrictor muscle of the pharynx at its origin from the posterior end of the mylo-hyoid line, it lies below and behind the last molar tooth (Fig. 71), between the mucous membrane of the mouth and the body of the mandible. At that point it is in danger of being hurt by the clumsy extraction of one of the lower molars, and there also it may be divided by the surgeon, from the inside of the mouth. In its further course the nerve keeps close to the side of the tongue, crossing the stylo-glossus and the upper part of the hyo-glossus and, beyond that, the submandibular duct. Its terminal branches are placed immediately under cover of the mucous membrane of the mouth, and can be traced as far as the tip of the tongue.

The *branches* which proceed from the lingual nerve in the submandibular region are of two kinds—(1) twigs of communication; (2) branches of distribution.

Twigs of *Communication.*	1. Two or more to the submandibular ganglion.
	2. One or two which descend along the anterior border of the hyo-glossus muscle to unite with the hypoglossal nerve.
Branches of Distribution	1. Slender filaments to the mucous membrane of the mouth and gums.
	2. A few twigs to the sublingual gland.
	3. Branches to the tongue.

The *lingual branches* pierce the substance of the tongue, and then incline upwards to supply the mucous membrane over the anterior two-thirds of the organ.

Submandibular Ganglion.—This small ganglion lies on the upper part of the hyo-glossus muscle, between the lingual nerve and the submandibular duct. In size, it is not larger than the head of a large pin; and, when freed from the surrounding areolar tissue, it will be seen to be suspended from the lingual nerve by two short branches. The posterior connecting twig is frequently replaced by two or three filaments which form the sensory and secretory (parasympathetic) roots of the ganglion, whilst the anterior connecting branch is a twig given by the ganglion to the lingual nerve.

Like the other ganglia developed in connexion with the branches of the trigeminal nerve, the submandibular ganglion has three roots—viz., (1) a *sensory root* from the lingual nerve; (2) a *secretory parasympathetic* *root* derived from the chorda tympani branch of the facial nerves; and (3) a *sympathetic root* whose fibres arise in the superior cervical ganglion of the sympathetic trunk and come into the submandibular ganglion from the plexus around the facial artery.

From its lower border several minute twigs proceed to the submandibular gland and duct; twigs are distributed also to the sublingual gland (from the branch given by the ganglion to the lingual nerve) and to the mucous membrane of the mouth.

The parasympathetic fibres are the only ones relayed in the ganglion; the new fibres that arise in the ganglion and the sympathetic fibres control the salivary secretion of the submandibular and sublingual glands.

Hypoglossal Nerve.—This nerve has been traced, in the dissection of the anterior triangle, to the point where it disappears under cover of the mylo-hyoid muscle (p. 158). It is now seen passing forwards on the hyo-glossus muscle above the hyoid bone and below the submandibular duct. At the anterior border of the hyo-glossus it gains the surface of the genio-glossus muscle, into the substance of which it sinks; and finally it breaks up into branches which supply the muscular substance of the tongue. On the hyo-glossus muscle, it is accompanied by a vein from the tongue.

The *branches* which spring from the hypoglossal nerve in the region of the floor of the mouth are very numerous, and are distributed entirely to muscles. It supplies—(1) the stylo-glossus; (2) the hyo-glossus; (3) the genio-glossus; (4) the genio-hyoid; and (5) the intrinsic muscles of the tongue.

In addition, it communicates freely with the lingual nerve. The more apparent of the connexions take the form of one or more loops which lie on the lateral surface of the anterior part of the hyo-glossus. Other communications with the lingual nerve are effected in the substance of the tongue.

***Dissection.*—Detach the hyo-glossus carefully from the hyoid bone, and throw it upwards, but do not divide the structures which lie upon its superficial surface. Clean the structures exposed by its reflexion.**

PARTS EXPOSED BY THE REFLEXION OF HYO-GLOSSUS.—By the reflexion of the hyo-glossus muscle the following structures, which were already partly exposed, will be fully displayed:—(1) the lingual artery and the veins which accompany it; (2) the dorsales linguæ arteries and veins; (3) the posterior part of the genio-glossus; (4) the origin of the middle constrictor of the pharynx; and (5) the attachment of the stylo-hyoid ligament.

Genio-Glossus.—The genio-glossus is a flat, triangular muscle, the medial surface of which is in contact with its fellow. It arises by a short, pointed tendon from the upper genial tubercle, and its fleshy fasciculi spread out in a fan-like manner into the tongue, to be inserted into it throughout its whole length. The genio-glossus is supplied by twigs from the *hypoglossal nerve.* It can project the tip of the tongue forwards; and it can depress the whole organ in the act of sucking.

Lingual Artery.—As this artery is now fully exposed, it can be conveniently studied as a whole at this stage.

It springs from the front of the external carotid artery immediately behind the tip of the greater horn of the hyoid bone, and its general direction is forwards and upwards. At first it makes a bend (convex upwards) above the tip of the horn; it then runs forwards above the hyoid bone under cover of the hyo-glossus, and, thirdly, upwards along the anterior border of the hyo-glossus to the tongue, where it ends by becoming the deep artery of the tongue.

Its **first part** extends from its origin to the hyo-glossus, and is fairly superficial in the carotid triangle, where it has been seen already. This part lies on the middle constrictor of the pharynx, above the tip of the hyoid bone, and is covered only by the skin and fasciæ and the hypoglossal nerve, which crosses the loop or bend of the artery. It gives off the *suprahyoid artery*, which runs forwards along the upper border of the hyoid bone, superficial to the hyo-glossus.

The **second part** is the part under cover of the hyo-glossus. It lies first on the middle constrictor and then on the genio-glossus, and crosses the stylo-hyoid ligament superficially. It gives off two or more *dorsales linguæ arteries.* They run upwards and backwards between the hyo-glossus and the genio-glossus, give branches to the muscular substance of the tongue and end in the mucous membrane of its pharyngeal surface and in the tonsil.

The **third part** runs upwards between the genio-glossus and the anterior border of the hyo-glossus. It is crossed by the branches of the hypoglossal nerve and by the submandibular duct and the lingual nerve. Its branch is the *sublingual artery*, which runs upwards and forwards to the sublingual gland to supply it and neighbouring muscles.

The **deep artery of the tongue** is the continuation of the lingual artery. It enters the tongue about its middle, and runs forwards to the tip, separated only by the deep vein from the mucous membrane of the lower surface of the tongue near the frenulum linguæ. Its course is tortuous to allow for the elongation of the tongue when protruded ; it gives numerous branches to the substance of the tongue. (In some descriptions, the *deep artery* includes the *third part* of the lingual.)

Veins of the Tongue.—These veins are inconstant in their arrangement. The lingual artery, however, usually has two *venæ comitantes*, which are joined by *dorsales linguæ* veins ; and a *vena comitans* often runs backwards along the upper border of the hypoglossal nerve. But the chief vein is the *profunda vein.* It begins near the tip and runs backwards near the median line of the lower part of the tongue, and can be seen shining through the mucous membrane in the living tongue ; it next descends along the anterior border of the hyo-glossus and then crosses the superficial surface of that muscle below the hypoglossal nerve. All these veins unite at the posterior border of the hyo-glossus to form **the lingual vein,** which either joins the common facial vein or runs backwards across the external and internal carotid arteries to join the internal jugular vein.

Glosso-pharyngeal Nerve.—This nerve will be described when it is more fully exposed (p. 234).

Stylo-Hyoid Ligament.—This is the last structure to be examined in this dissection. It is a fibrous cord which springs from the tip of the styloid process and passes downwards and forwards to be attached, under cover of the hyo-glossus muscle, to the lesser cornu of the hyoid bone. It may be a stout cord, or may be so slender that it escapes notice ; it is not uncommon to find it partially ossified ; or it may assume a ruddy hue and contain muscular fibres.

The dissectors will now return to the Neck and begin its deep dissection. Or, if they dissected the root of the neck before the parotid region, they will resume the deep dissection of the neck at p. 226.

DEEP DISSECTION OF NECK

The structures in this region are numerous and important. For the most part, they lie under cover of the sterno-mastoid muscle, and therefore are not seen in either of the great triangles of the neck unless the sterno-mastoid is displaced. In the lower part of the neck, some of these structures are under cover of the infrahyoid muscles also; and, in the upper part, some of them are concealed by the parotid gland and the parts near it.

The structures to be displayed include, in addition to some of the muscles attached to the vertebral column :—

(1) The great vessels and nerves of the neck.
(2) The thoracic duct.
(3) The thyroid and parathyroid glands.
(4) The upper end of the thymus.
(5) The trachea and œsophagus.
(6) The cervical pleura.
(7) The styloid process and its muscles.

Dissection.—Identify the sterno-hyoid, sterno-thyroid and superior belly of the omo-hyoid again. Push aside the sterno-mastoid and the omo-hyoid. Divide the sterno-thyroid near its lower end and turn it upwards to its insertion, preserving its nerve supply. Clear the fat from the front of the trachea, but preserve the *inferior thyroid veins*. Look amidst the fat for the upper ends of the two lobes of the *thymus*; they sometimes extend into the neck, and, though they resemble the fat, they are duller in colour, are firmer and are ensheathed in fascia.

Remove the fascia from the *thyroid gland*, and clean the vessels that enter and leave it. Lift the lower part of the lobe of the gland, and clean the *trachea* and *œsophagus* and the *recurrent laryngeal nerve*, which lies in the groove between them. Dissectors of the left side will look carefully for the *thoracic duct* on the left border of the œsophagus, and clean it. Identify the *external laryngeal nerve* again, and trace it to its termination. Clean the *crico-thyroid* muscle and the lower part of the *inferior constrictor* muscle.

Thymus.—The thymus is one of the ductless glands, but in the adult it has little glandular substance and consists chiefly of fat and fibrous tissue. Its pair of lobes are two slender, elongated yellowish bodies that lie side by side in front of the pericardium and great vessels of the upper part of the thorax; but their upper ends may extend into the neck in front of the trachea. (See Vol. II.)

Thyroid Gland.—The thyroid gland also belongs to the group of ductless glands. It is a highly vascular, solid body which clasps the upper part of the trachea and extends upwards for some distance on each side of the larynx. It is enclosed in a sheath of the pretracheal fascia, which is attached above to the arch of the cricoid and the oblique line of the thyroid cartilage; the gland moves therefore with the larynx in all its movements. It possesses also its own proper fibrous capsule, which is continuous with the stroma of the gland. Between the sheath and the capsule, the arteries of supply ramify before they enter the gland substance, and the emerging veins anastomose with one another to form a network from

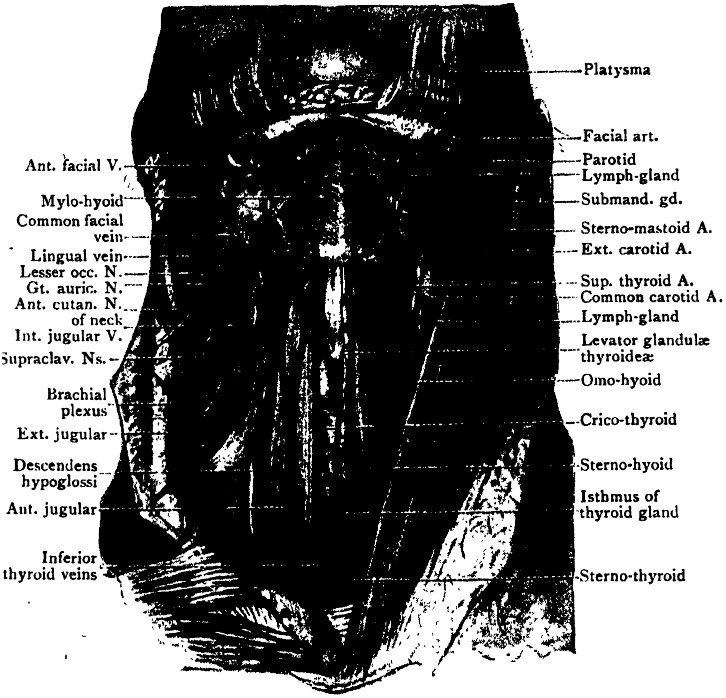


FIG. 77.—Dissection of the Anterior Part of the Neck. The Right Sterno-Mastoid has been removed.

which the various thyroid veins arise. It varies greatly in size in different bodies; and in women and children it is always relatively larger than in men. It has three well-marked subdivisions, viz., *a pair of lobes* joined across the median plane by the *isthmus*.

Each **lobe** is more or less conical in form. Its *base* or lower end is at the level of the fifth or the sixth tracheal ring, near the medial end of the clavicle; its *apex* rests against the side of the thyroid cartilage. Its *superficial* or *lateral surface* is full and rounded; it is covered by the sterno-thyroid, sterno-hyoid and omo-hyoid muscles, and is overlapped by the anterior border of the sterno-mastoid (Fig. 80). Its *medial surface* is moulded on the parts upon which it lies, viz.—in its lower part, the trachea and œsophagus, and the recurrent laryngeal nerve between them; in its upper part, the cricoid and thyroid cartilages, the crico-thyroid and inferior constrictor muscles, and the external laryngeal nerve. Its *posterior* surface varies in width; it is related to the longus cervicis muscle, and it overlaps the common carotid artery.

The **isthmus** is a band of varying width which lies under cover of the skin and fasciæ of the median line of the neck, on the second, third and fourth rings of the trachea, and is, therefore, nearer the lower than the upper ends of the two lobes.

An additional lobe—the *pyramidal lobe*—is frequently present. It is an elongated slender process which springs from the isthmus on one or other side of the median plane (more usually on the left side), and extends upwards towards the hyoid bone. It may be connected to the hyoid bone by fibrous tissue or by a narrow slip of muscular fibres called the *levator glandulæ thyroideæ*. In some bodies, that little muscle has an attachment to the thyroid gland independently of the pyramidal lobe.

Blood-Supply.—Note the great vascularity of the thyroid gland. Two pairs of large arteries, and, occasionally, an additional small artery, convey blood to its substance. At the apex of each lobe the *superior thyroid artery* divides into either two or three branches which supply the gland. The *inferior thyroid artery* distributes its terminal branches to the basal portion and deep surface of the lobe. The inferior thyroid artery has not yet been dissected; it springs from the thyro-cervical trunk—a branch of the subclavian. The occasional artery is the *thyroidea ima*—a branch of the innominate or, more rarely, of the left common carotid or the aortic arch. It ascends over the front of the trachea to reach the isthmus of the thyroid gland. The various thyroid arteries anastomose freely with one another on each lobe; but, except for a branch that runs along the upper border of the isthmus, there is little anastomosis across the median plane.

Three pairs of veins drain the blood from the gland—

superior, middle and inferior. They arise, in part, by tributaries which spring from a venous network on the superficial surface of the gland, but chiefly by branches which emerge from its substance through its deep surface.

The *superior thyroid vein* arises near the upper end of the lobe, emerges from under cover of the sterno-thyroid and omohyoid muscles into the carotid triangle, and runs across the common carotid artery to join the internal jugular vein, or runs upwards alongside the superior thyroid artery and ends in the common facial vein. It receives tributaries that correspond in great measure with the branches of the superior thyroid artery. The *middle thyroid vein* is very short; it arises near the lower end of the lobe, and

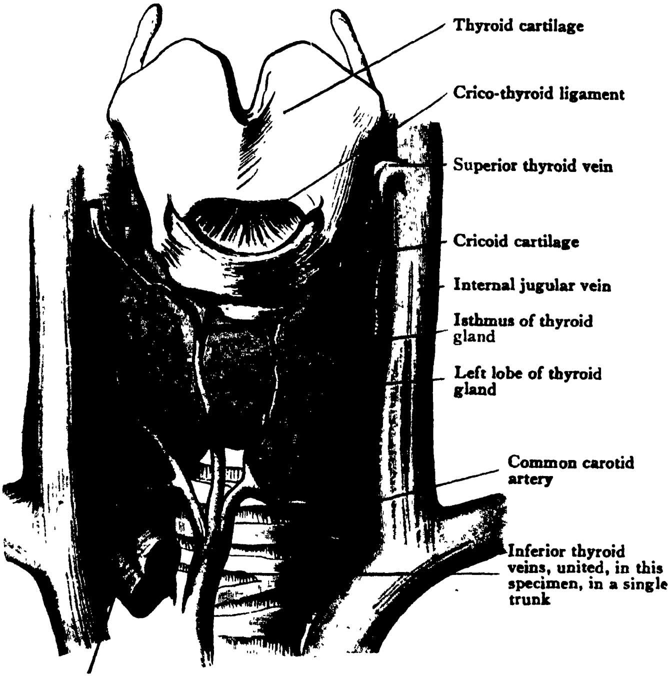


FIG. 78.—Dissection of the Thyroid Gland and of the Parts in immediate relation to it.

passes across the common carotid to enter the internal jugular. The right and left *inferior thyroid veins* are close together. They arise from the network on the isthmus or from the downward continuation of that network, and descend over the front of the trachea into the thorax. Both trend to the right, and each usually ends in the innominate vein of its own side near the junction of the innominates ; but they may form one stem (Fig. 78) which ends in one or other of the innominates. On their way down, they receive tributaries from the larynx, trachea and œsophagus.

Nerve-Supply.—The nerves are derived from the cervical ganglia of the sympathetic trunk and from the cardiac and laryngeal branches of the vagus.

> ***Dissection.*****—Divide the isthmus. Cut the vessels of one of the lobes and remove it. Examine the back of it, and note, towards the medial side, a longitudinal artery that connects branches of the superior and inferior thyroid arteries. Using fine-pointed forceps, look for the *parathyroid glands* immediately lateral to that anastomosing channel.**

Structure.—The dissectors can obtain some indication of the special structure of the thyroid gland by examining sections of it with a hand-lens. It is made up of a large number of closed vesicles held together by a stroma or framework of delicate fibrous tissue, and filled with a semi-liquid *colloid substance* which is coagulated by preservatives. The vesicles vary greatly in size; they may normally reach a diameter of 1 mm., and many of them are therefore visible to the naked eye. In some forms of goitre they are greatly enlarged owing to distension with accumulated colloid—a substance whose significance is not understood. The active principle of the thyroid secretion—an iodine compound known as *thyroxin*—is a powerful stimulant of the metabolism of the body; and, since accumulation of colloid is a sign of physiological sluggishness, it is probable that the active principle passes mainly into the veins of the organ without entering the colloid substance.

Lymph-vessels.—The lymph-vessels are of special importance, for the colloid secretion of the vesicles is believed to be removed by them. They pass mostly to glands near at hand —on the surface of the thyroid gland itself, on the front and sides of the trachea and on the carotid sheath (deep cervical glands). Occasionally, one passes from the apex of the lobe to a retro-pharyngeal gland ; another may descend into the thorax with the inferior thyroid veins to end in a mediastinal gland ; and others have been seen to end in the thoracic duct

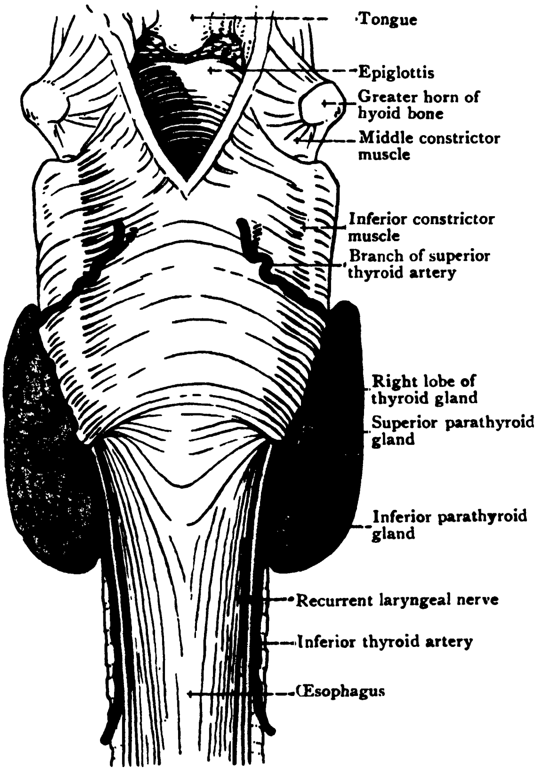

Tongue
Epiglottis
Greater horn of hyoid bone
Middle constrictor muscle
Inferior constrictor muscle
Branch of superior thyroid artery
Right lobe of thyroid gland
Superior parathyroid gland
Inferior parathyroid gland
Recurrent laryngeal nerve
Inferior thyroid artery
Œsophagus

FIG. 79.—Dissection showing the Thyroid Gland and the four Parathyroid Glands from behind.

—or even directly in the internal jugular vein—without the intervention of a lymph-gland.

Parathyroid Glands.—The parathyroids (two pairs) belong to the system of ductless glands, and are important out of proportion to their small size, for their secretion is an important regulator of calcium metabolism. Each is of the size of a small flattened pea ; and they are usually embedded in the back of the capsule of the thyroid gland—the upper at the middle of the lobe and the lower near its lower end (Fig. 79). The *superior parathyroid gland* is more constant in position than the inferior, for the *inferior parathyroid gland* is developed in association with the thymus, and may be drawn down with the thymus—even into the thorax. The best guide to them is the inferior thyroid artery, from which each of them receives a small individual twig. Their colour, which is yellowish brown, is of value in distinguishing them from other small structures found on the back of the thyroid gland and sometimes mistaken for parathyroids—such as lymph-glands, pellets of fat and detached portions of the thyroid gland. The parathyroid glands are clumps of cells divided into columns by sinusoidal blood-capillaries.

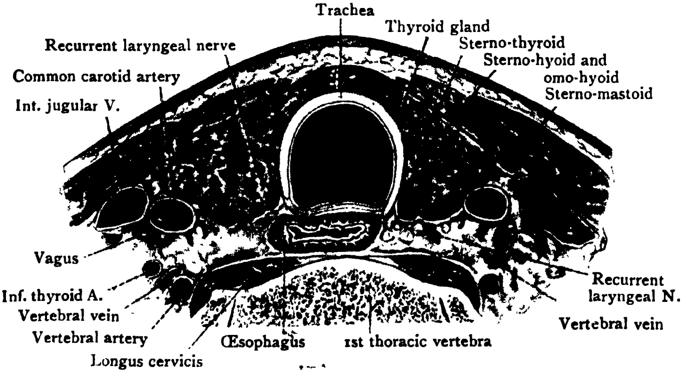


FIG. 80 —Transverse Section at the level of the First Thoracic Vertebra.

Dissection.—**Complete the cleaning of the *trachea* and *œsophagus*, and examine their relations.**

Trachea and Œsophagus.—Both begin at the level of the cricoid cartilage in front of the sixth cervical vertebra. From that point they extend downwards and backwards, in front of the vertebral column, into the thorax.

The **trachea** or *windpipe* is a wide tube kept constantly patent by the cartilaginous curved bars embedded in its walls. The bars are deficient posteriorly, and the posterior surface of the trachea is therefore flat. The trachea is continuous above with the larynx; and, in the neck, it is in the median plane. The *anterior* relations of the trachea have already been fully discussed (p. 152). *Posteriorly*, it rests on the gullet. A common carotid artery and a lobe of the thyroid gland lie *on each side* of it, the lobe being closely applied to its upper part. A recurrent laryngeal nerve ascends, on each side, in the angle between the trachea and œsophagus; and on the right side, the innominate artery is related to its lower part.

The **œsophagus** or *gullet* is a tube, with thick muscular walls and narrow lumen, which extends from the pharynx to the stomach (Figs. 79, 80, 94, 95, 110). In the neck, it lies behind the trachea on the anterior longitudinal ligament of the vertebræ and overlaps the longus cervicis muscles. Its *right side* is related to the cervical pleura at the root of the neck, and to the thyroid gland and the common carotid artery at a higher level. On the *left side*, it is separated from the pleura by the subclavian artery and the thoracic duct; higher up, it is related to the thyroid gland and the common carotid artery. As it descends it inclines to the left and protrudes beyond the left side of the trachea (Figs. 80, 110B). Its left margin is therefore more closely related to the thyroid gland than the right margin and also is more accessible to the surgeon.

The dissectors will now clean the vessels and nerves in the lower part of the neck and will expose the cervical pleura.

Dissection.—**Take away the fascial sheath from the *common carotid artery* and the lower part of the *internal jugular vein*, removing the fat and the lymph-glands at the same time. Separate the vein and artery, find the *vagus nerve* between them, and clean it. On the right side, find the *recurrent laryngeal nerve*, which springs from the vagus as it crosses the subclavian artery; follow it round the subclavian artery and onwards to the groove between the trachea and œsophagus. On the left side, find the *thoracic duct*: look for it behind the common carotid and internal jugular vein and then in front of the subclavian artery.**

On both sides, clean the cervical part of the *innominate vein*, and secure the tributaries that enter it in the neck. On the right side, clean the small portion of the innominate artery that lies in the neck.

The *phrenic nerve* has been found already on the surface of the scalenus anterior: trace it downwards till it disappears into the thorax.

Displace the internal jugular vein medially, avoiding injury to the thoracic duct (on left side) and to the *vertebral vein*, which is behind the internal jugular. Carefully remove the fat from the part of the *subclavian artery* exposed, and from the cervical pleura above and below the artery. Trace the *internal*

mammary artery, which runs downwards from the subclavian. Identify the _thyro-cervical trunk_, which springs from the front of the subclavian artery, and clean its three branches—the _suprascapular_, the _transverse cervical_ and the _inferior thyroid_.

Pull the scalenus anterior gently in a lateral direction and find the _costo-cervical trunk_, which springs from the subclavian at the medial margin of the muscle or behind it ; follow the trunk upwards over the cervical pleura to the neck of the first rib.

Displace the internal jugular vein laterally, and the common carotid artery medially—again avoiding injury to the vertebral vein, and, on the left side, to the thoracic duct. Clear away the fat from behind these vessels, and find the _vertebral artery_, which springs from the subclavian. Trace the vertebral artery upwards in front of the _seventh cervical transverse process_ to the sixth process, where it disappears. Push the vertebral artery medially ; clear away the fat behind it, and find the anterior primary ramus of the _eighth cervical nerve_ below the seventh transverse process, and the _seventh nerve_ above it.

Displace the common carotid artery laterally, and find the _sympathetic trunk_ behind it. Trace the trunk upwards and downwards. Find its _inferior cervical ganglion_ between the seventh transverse process and the neck of the first rib (partly tucked in behind the vertebral artery) and its _middle cervical ganglion_—a mere pin head—on the inferior thyroid artery near the sixth transverse process.

Innominate Artery.—This great artery arises in the thorax from the arch of the aorta, passes upwards and to the right, and ends by dividing into the right subclavian and right common carotid arteries behind the upper margin of the right sterno-clavicular joint. A small portion of it is therefore in the neck. That portion is behind the joint, from which it is separated by the sterno-thyroid and sterno-hyoid muscles. The trachea is on its medial side, and the right innominate vein is lateral to it. Behind it, there is a quantity of fat which separates it from the pleura and the longus cervicis muscle ; and in that fat the right vagus nerve descends obliquely to reach the trachea.

Subclavian Artery.—The subclavian artery is the first portion of the great arterial trunk which carries blood for the supply of the upper limb and the lower and posterior parts of the brain.

On the *right side*, it takes origin behind the sterno-clavicular joint as a terminal branch of the innominate artery. On the *left side*, it arises in the thorax from the aortic arch and ascends to enter the neck behind the sterno-clavicular joint. On each side, it takes an arched course laterally across the root of the neck, behind the scalenus anterior and on the front of the cervical pleura a short distance below its summit. At the outer border of the first rib it becomes the axillary artery.

For descriptive purposes, the artery is divided into three parts. The *first part* extends from the origin of the vessel to the medial margin of the scalenus anterior; the *second part* lies behind that muscle; and the *third part* extends from its lateral border to the outer border of the first rib.

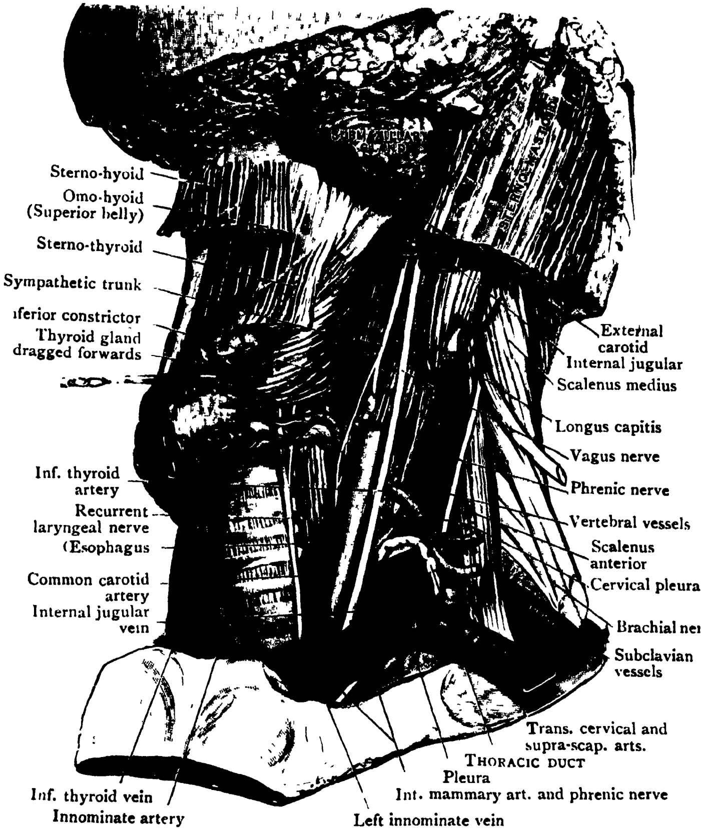


FIG. 81.—Deep Dissection of Root of Neck on the Left Side to show the Cervical Pleura and the Relations of the Thoracic Duct. The sterno-mastoid and the infrahyoid muscles have been removed.

The *third part* has been dissected already, and is described on p. 55.

First Part.—Owing to the difference of origin, the relations of the first portion of the subclavian artery are not the same on the two sides of the body.

The first part of the **right subclavian** extends obliquely upwards and laterally, and at its termination at the medial margin of the scalenus anterior it has reached a point about half an inch above the level of the clavicle. It is placed very deeply. *Anteriorly*, it is covered by the skin, superficial fascia, platysma, deep fascia, and three muscular strata—viz., the sterno-mastoid, the sterno-hyoid, and the sterno-thyroid. Three veins and some nerves are in front of it:—At the medial margin of the scalenus anterior it is crossed by the internal jugular and vertebral veins; and the anterior jugular vein, as it passes laterally under cover of the sterno-mastoid, is separated from it by the sterno-hyoid and sterno-thyroid muscles. The nerves which cross in front of it are the vagus, a loop from the sympathetic (ansa subclavia), and, sometimes, cardiac branches of the vagus and sympathetic as they run to the thorax. The common carotid artery also is in front of it near its origin.

The cervical pleura is both *below* and *behind* the artery, separated from it by a thin fibrous sheet called the suprapleural membrane. At the lower margin of the artery, the vagus gives off its recurrent laryngeal branch, which hooks round below it and ascends behind it. If the lung has been removed by the dissector of the Thorax, investigate the lower and posterior relations from the thoracic side.

The first part of the **left subclavian** ascends almost vertically from the aortic arch, and, when it reaches the root of the neck, it passes upwards and laterally to the medial margin of the scalenus anterior. The relations of the cervical part are slightly different from those on the right side. The same fascial and muscular layers, and the same nerves and veins, are in front of it. But in the root of the neck, the veins and nerves of both sides trend to the right; on the left side, therefore, they are more or less parallel to the part of the subclavian artery that ascends behind the sterno-clavicular joint. Three additional relations are established, viz., the phrenic nerve and the thoracic duct descend in front of it near the scalenus anterior; and the left innominate vein is in front of it, behind the joint (Fig. 81).

The left recurrent nerve hooks round the arch of the aorta, and lies to the medial side of the subclavian artery.

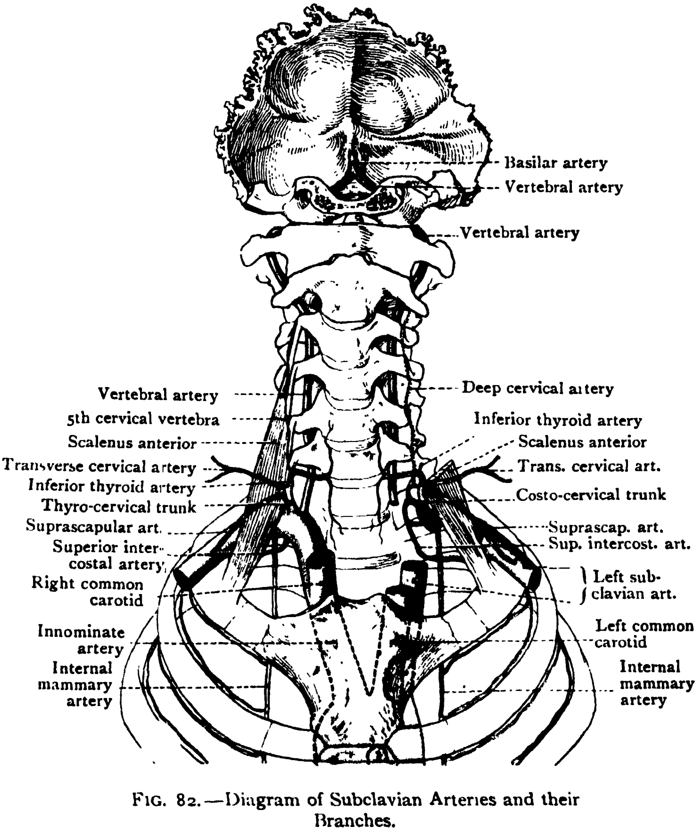


FIG. 82.—Diagram of Subclavian Arteries and their Branches.

Second Part.—The second portion of the subclavian artery forms the highest part or summit of the arch, and rises above the level of the clavicle for half an inch to an inch.

In that part of its course the vessel has not so many superficial relations. *Anteriorly*, it is covered by—(1) skin; (2) superficial fascia and platysma; (3) deep fascia; (4)

clavicular head of the sterno-mastoid; (5) scalenus anterior. On the right side the phrenic nerve also is an anterior relation, but it is separated from the artery by the medial margin of the scalenus anterior. *Posteriorly and inferiorly*, the vessel is in relation with the pleura—the suprapleural membrane intervening.

Subclavian Vein.—The vein corresponds to the third and second parts of the artery. It lies at a lower level than the artery and on an anterior plane, and is separated from the second part by the scalenus anterior. It is described on p. 56. Note that the external jugular vein is its only tributary, and that veins which accompany branches of the subclavian artery therefore do not end in it, though the suprascapular and transverse cervical veins, by joining the external jugular, send their blood indirectly to it.

BRANCHES OF SUBCLAVIAN ARTERY.—Four branches spring from the subclavian trunk (Fig. 82). Three take origin, as a general rule, from the first part of the artery, and one from the second part. They are:

From the *first part.*	1. Vertebral.	
	2. Thyro-cervical.	Inferior thyroid. Transverse cervical. Suprascapular.
	3. Internal mammary.	
From the *second part.*	Costo-cervical.	Superior intercostal. Deep cervical.

In many subjects, a branch of considerable size springs from the third part of the subclavian artery. Sometimes it proves to be the suprascapular artery. More often, it takes the place of the deep branch of the transverse cervical artery and is then called the *descending scapular artery*, while the branch of the thyro-cervical trunk that does duty as the superficial branch of the transverse cervical is called the *superficial cervical artery*.

Vertebral Artery.—This is the first branch of the subclavian. The right artery springs from the upper and back part of the subclavian near its origin; the left arises opposite the upper part of the sterno-clavicular joint.

Only a small portion of it is seen in the present dissection. It proceeds upwards, in the interval between the longus cervicis and the scalenus anterior muscles, and disappears into the foramen transversarium of the sixth cervical vertebra. It is placed very deeply behind the common carotid artery and its own vein; it is in front of the seventh cervical transverse process and the eighth and seventh cervical nerves. The sympathetic trunk lies along its medial side ; and the inferior cervical ganglion, which is partly behind it, gives off branches that form a plexus around it.

The inferior thyroid artery crosses in front of it immediately below the sixth vertebra ; and the thoracic duct crosses in front of the left vertebral artery a little lower down.

Vertebral Vein.—The vein issues from the aperture in the transverse process of the sixth cervical vertebra. It passes downwards, antero-lateral to its companion artery, and behind the internal jugular vein, to open into the back of the innominate vein a little below its commencement. Near its termination it crosses the subclavian artery. It receives the *deep cervical vein* and the *anterior vertebral vein* and, occasionally, the *first posterior intercostal vein.*

Thyro-Cervical Trunk.—This short, wide vessel arises from the front of the subclavian artery close to the medial margin of the scalenus anterior, and under cover of the internal jugular vein between the phrenic and vagus nerves. It breaks up almost immediately into three branches—viz., the inferior thyroid, the suprascapular, and the transverse cervical.

The *suprascapular* and *transverse cervical arteries* are described on pp. 56, 57.

Inferior Thyroid Artery.—The inferior thyroid artery takes a sinuous course to reach the thyroid gland. First, it ascends for a short distance along the medial border of the scalenus anterior and under cover of the internal jugular vein ; then, at the level of the cricoid cartilage, it turns suddenly medialwards and passes across the vertebral artery, behind the vagus, the sympathetic trunk and the common carotid artery, to reach the middle of the posterior border of the thyroid gland. After giving off branches to the pharynx and larynx, it descends along the back of the gland, and ends in tracheal, œsophageal and glandular branches.

The inferior thyroid artery is not accompanied by a vein. The *inferior thyroid veins* run downwards over the trachea, and are described on p. 208.

The following are the branches of the artery :—

1. Ascending cervical.
2. Inferior laryngeal.
3. Pharyngeal.
4. Tracheal.
5. Œsophageal.
6. Glandular.
7. Muscular.

The *ascending cervical artery* (Fig. 81) is a small but constant vessel which runs upwards, on the front of the transverse processes between the origins of the scalenus anterior and longus capitis, and gives branches to the muscles in front of the vertebral column. It gives off *spinal branches* also, which enter the vertebral canal upon the spinal nerves.

The companion vein is called the *anterior vertebral*; it descends alongside the artery, and opens into the vertebral vein as it escapes from the sixth transverse process.

The *inferior laryngeal artery* is a small vessel which accompanies the recurrent laryngeal nerve to the larynx.

The *tracheal, œsophageal, pharyngeal* and *muscular branches* are small irregular twigs.

One of the *glandular branches* ascends along the back of the lobe of the thyroid gland to anastomose with the superior thyroid ; it supplies the parathyroid glands on the way.

Internal Mammary Artery.—This is a long artery which runs only a small part of its course in the neck. It arises from the lower surface of the subclavian near the medial border of the scalenus anterior, and runs downwards and medially to enter the thorax behind the first costal cartilage.

In the neck, the artery lies on the pleura behind the medial part of the clavicle. The *left* artery is behind the end of the subclavian vein and the beginning of the innominate. The *right* artery is behind the internal jugular and innominate veins; and the phrenic nerve crosses it, as it lies behind the innominate, from lateral to medial side and usually in front of it.

The artery is not accompanied by a vein in the neck, for the *internal mammary vein* ends in the innominate vein at the inlet of the thorax.

Costo-Cervical Trunk.—This trunk is a short artery that arises from the back of the subclavian near the medial margin of the scalenus anterior—the right trunk from the second part of the subclavian, the left sometimes from the first part. It arches upwards and backwards over the top of the pleura to reach the neck of the first rib, where it divides into the *deep cervical artery* and the *superior intercostal artery*.

The *deep cervical artery* passes backwards and disappears from view between the transverse process of the seventh cervical vertebra and the neck of the first rib. It has been noticed already in the dissection of the back of the neck (p. 71).

The *deep cervical vein* is a large vessel. It joins the vertebral vein.

The *superior intercostal artery* turns downwards, in front of the neck of the first rib, between the first thoracic nerve and the first thoracic ganglion of the sympathetic trunk. It gives a posterior intercostal branch to the first space and ends as the posterior intercostal artery of the second space (Fig. 82).

If the lung has been removed, examine the trunk and the superior intercostal artery from the thoracic side.

The *first posterior intercostal vein* ascends from the first intercostal space across the front of the neck of the first rib, and, curving downwards over the pleura, it usually passes behind the subclavian artery to end in the innominate vein.

Innominate Veins.—The innominate veins are the wide vessels that collect the blood from the head and neck and the upper limbs. They receive blood also from the walls of the thorax, and even from the anterior wall of the abdomen. They lie partly in the neck and partly in the thorax ; and they end by joining to form the superior vena cava opposite the lower border of the first costal cartilage behind the right margin of the manubrium sterni. They are devoid of valves.

Each innominate vein begins in the neck below the subclavian artery, on the front of the cervical pleura, behind the medial part of the clavicle, and is formed by the union of the subclavian vein and the internal jugular vein.

The **right vein** passes downwards and slightly medially to enter the thorax behind the first costal cartilage. It lies on the cervical pleura, with the phrenic nerve and the internal mammary artery between it and the pleura. It is behind the sterno-thyroid and sterno-hyoid muscles, and, farther forward, the clavicle and the costo-clavicular ligament. The innominate artery is medial to it; and the vagus lies in the fat behind the interval between those two large vessels.

The **left vein** is much longer because it has to cross behind the upper part of the manubrium to meet the right vein. In the neck, it lies first behind the clavicle in front of the pleura and the internal mammary artery, and, next, behind the sterno-clavicular joint (from which it is separated by the sterno-thyroid and sterno-hyoid muscles) and in front of the phrenic and vagus nerves, the ascending part of the left subclavian artery and the common carotid artery.

Tributaries in the Neck.—The right vein receives the vertebral vein, the first posterior intercostal vein, and one or two lymph-trunks (p. 222). The left vein receives the vertebral and first posterior intercostal veins, the thoracic duct, and usually one or two separate lymph-trunks (pp. 221, 222).

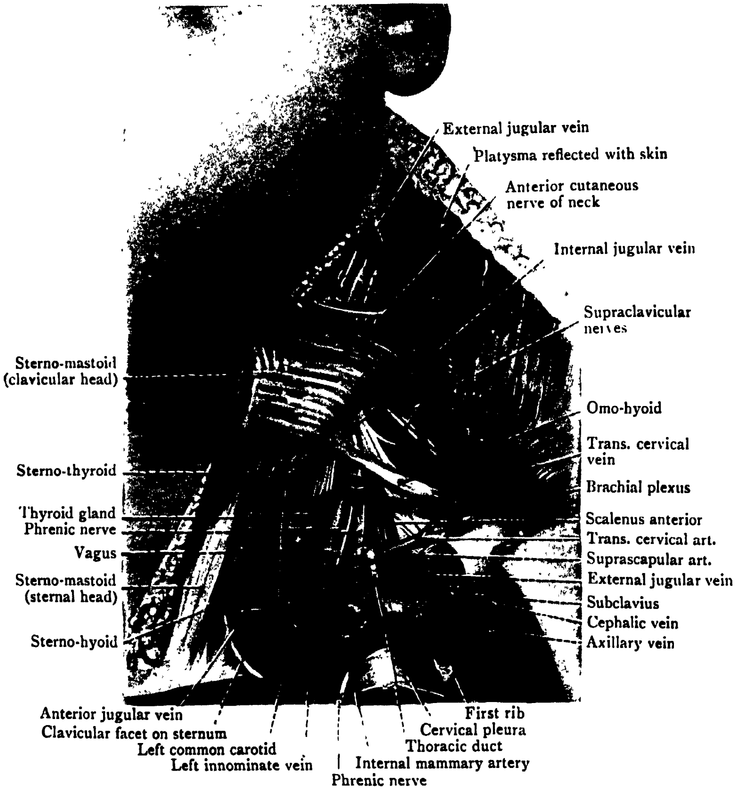


FIG. 83.—Deep Dissection of Root of Neck on the Left Side to show Cervical Pleura and the Relations of Thoracic Duct.
Parts of the sterno-mastoid and the sterno-thyroid have been removed.

***Thoracic Duct.**—The thoracic duct is the vessel by means of which the lymph from the greater part of the body is poured* into the venous system. The maximum field of drainage is the left half of the body above the diaphragm and both halves below the diaphragm (excepting the upper part of the right lobe of the liver and the upper right quarter of the anterior wall of the abdomen). The maximum is, however, seldom attained, for one or more of the three lymph-trunks that drain the upper part of each half of the body usually enter the veins directly—as explained below. The lymph from the small intestine is known as *chyle*, and it gives a milky appearance to the contents of the thoracic duct, as it contains the fat absorbed from the food.

The thoracic duct is a slender, thin-walled vessel—frequently mistaken for a vein. It ascends from the thorax into the root of the neck along the left margin of the œsophagus till it reaches the level of the seventh cervical vertebra—that is, about a finger's breadth below the cricoid cartilage. There, it leaves the œsophagus and arches first laterally behind the carotid sheath and then downwards across the front of the subclavian artery to end by opening into the commencement of the left innominate vein, in the angle of junction of its subclavian and internal jugular tributaries. A valve of two segments guards its entrance.

As the thoracic duct passes laterally, it is above the level of the subclavian artery and the pleura (but may be in front of the pleura—see Fig. 84). It crosses behind the common carotid artery, the vagus and the internal jugular vein, in front of the sympathetic trunk and the vertebral vessels and the root of the inferior thyroid artery. Then, reaching the scalenus anterior, it bends downwards, in front of the transverse cervical and suprascapular arteries and the phrenic nerve; and, finally, passes off the scalenus anterior on to the subclavian artery. It may pass between the vertebral artery and vein instead of anterior to the vein.

In the root of the neck, there are three other terminal lymph-trunks on each side—subclavian, jugular and mediastinal. The *subclavian trunk* drains the lymph from the upper limb; the *jugular trunk* from its own half of the head and neck; and the *mediastinal trunk* from the lung, from the corresponding half of the mediastinum and (through its internal mammary tributary) from part of the anterior wall of the thorax and abdomen.

These trunks are so slender that they are seldom, if ever, found in an ordinary dissection; and their mode of termination is very variable. They may all open separately into one or other of the great veins in the root of the neck, or they may unite together in a variety of ways. Their number may be increased by division of one of them, or by some of their tributaries ending independently—for example, the main efferent from the internal mammary lymph-glands may fail to join the mediastinal trunk. On the left side, the mode of ending is influenced, in addition, by the presence of the thoracic duct, which itself may break up into several divisions. The following statement may, therefore, be taken as indicating only what is probably the commonest arrangement of the trunks.

On the left side, the jugular trunk ends in the thoracic duct, and the other two trunks may do so also; but the subclavian trunk often ends in the subclavian vein, and the mediastinal trunk usually ends in the innominate vein.

On the right side, the subclavian, jugular and mediastinal trunks usually have separate entrances into the subclavian, internal jugular and innominate veins, respectively. But it is not uncommon for the subclavian and jugular trunks to unite at the medial margin of the scalenus anterior above the subclavian artery. The resulting vessel is called the *right lymphatic duct.* It descends across the front of the subclavian artery to enter the innominate vein at its commencement. In rare cases the mediastinal trunk also joins the duct; and its internal mammary tributary may have independent entrance into the innominate vein.

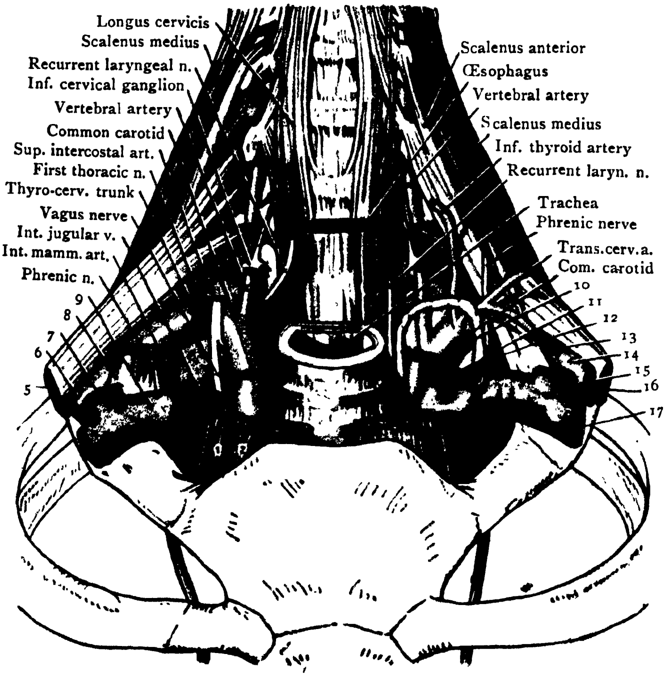


FIG. 84.—Dissection showing the Relations of the Cervical Pleura (semi-diagrammatic).

1. Sterno-thyroid.
2. Sterno-hyoid.
3. Apex of right pleural sac.
4. Apex of left pleural sac.
5. Brachial plexus.
6. Subclavian artery.
7. External jugular vein.
8. Scalenus anterior.
9. Subclavian vein.
10. Thoracic duct.
11. Internal jugular vein.
12. Internal mammary artery.
13. Suprascapular artery.
14. Subclavian artery.
15. External jugular vein.
16. Brachial plexus.
17. Subclavian vein.

Cervical Pleura.—The pleural sac of each side, with the apex of the lung, bulges upwards into the root of the neck, and the dissectors should now examine the height to which it rises, and the connexions which it establishes. Its height, with reference to the first pair of costal arches, varies in different bodies. In some bodies it extends upwards for two inches above the sternal end of the first rib; in others, for not more than one inch. The differences depend on the degree of obliquity of the thoracic inlet. Posteriorly, the apex of the pleura is usually at the level of the neck of the first rib (Fig. 84). It forms a dome-like roof for each side of the thoracic cavity, and is strengthened by a fascial expansion called the *suprapleural membrane*. This membrane springs from the seventh cervical transverse process, and spreads over the pleura like a fan to be attached to the inner margin of the first rib.

The cervical pleura is in relation with :—

1. Scalenus anterior.
2. Scalenus medius.
3. Subclavian artery.
4. Vertebral artery.
5. Costo-cervical trunk.
6. Superior intercostal artery.
7. Internal mammary artery.
8. Innominate vein.
9. First posterior intercostal vein.
10. Vertebral vein.
11. Subclavian vein.
12. Vagus nerve.
13. Phrenic nerve.
14. Recurrent nerve, on the right side.
15. First thoracic nerve.
16. First thoracic ganglion.
17. Ansa subclavia.

The *scalenus medius* is lateral to the dome of the pleura, and the *scalenus anterior* covers the antero-lateral part of it, separating it from the *subclavian vein*, which ends at the medial border of the muscle. Immediately above the vein, the *subclavian artery* crosses the dome below its summit. The *vertebral artery* ascends from the subclavian, and the *vertebral vein* is superficial to the vertebral and subclavian arteries. The *internal mammary artery* descends from the subclavian, passes behind the *innominate vein*, and, on the right side, is crossed, as it lies behind the vein, by the *phrenic nerve*, which passes usually in front of the artery, but sometimes behind it. The *first posterior intercostal vein* arches forwards and downwards over the apex of the pleura. The *costo-cervical trunk* arches backwards from the subclavian and crosses the summit of the dome; its *superior intercostal branch* descends behind the dome, between the *first intercostal nerve* on the lateral side and the *first thoracic* *sympathetic ganglion* on the medial side. The *vagus nerve* descends in front of the medial part of the subclavian artery; on the right side, its *recurrent laryngeal branch* turns round the lower border of the artery, and the *ansa subclavia* lies to the lateral side of the recurrent nerve.

Common Carotid Artery.—The common carotid artery arises differently on the two sides. The right artery arises as a terminal branch of the innominate artery, behind the sterno-clavicular joint. The left artery arises in the thorax from the arch of the aorta, passes upwards and to the left, and enters the neck behind the left sterno-clavicular joint.

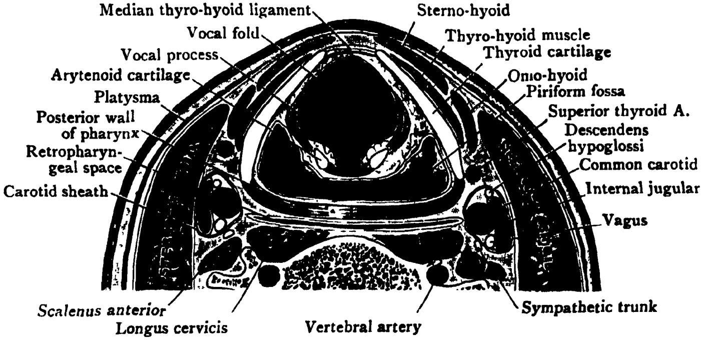


FIG. 85.—Transverse Section through the Neck at the level of upper part of the Thyroid Cartilage.

From the sterno-clavicular joint each artery runs upwards, backwards, and slightly laterally to the level of the upper border of the thyroid cartilage, which is opposite the disc between the third and fourth cervical vertebræ; it ends there by dividing into the internal and the external carotid arteries. Usually it has no other branches; but, if it reaches a higher level than the upper border of the thyroid cartilage, the superior thyroid or the ascending pharyngeal may spring from it.

It is enclosed, with the internal jugular vein and the vagus, in a fascial tube called the *carotid sheath*. The vein is on its *lateral* side, and may overlap it anteriorly. The vagus is in the posterior part of the interval between the vessels.

Superficial Relations.—The part that lies above the level of the superior belly of the omo-hyoid has been seen already in the dissection of the carotid triangle. It is covered by the skin, the superficial fascia and the platysma, the deep fascia and the anterior margin of the sterno-mastoid. It is crossed, immediately above the omo-hyoid, by the sterno-mastoid branch of the superior thyroid artery, and, at a little higher level, by the superior thyroid vein.

In the lower part of its extent it lies more deeply. Its superficial relations are:—the skin and superficial fascia, the deep fascia and the sterno-mastoid; the anterior jugular vein, crossing transversely, deep to the sterno-mastoid a little above the clavicle; the omo-hyoid, the sterno-hyoid, and the sterno-thyroid muscles. Deep to the muscles, it is overlapped by the thyroid gland; the *ansa hypoglossi* and its branches are in front of its sheath; and the middle thyroid vein crosses it to join the internal jugular vein (Fig. 59). At the root of the neck, the *left* artery is behind the sterno-clavicular joint—separated from the joint by the left innominate vein and the sterno-thyroid and sterno-hyoid muscles.

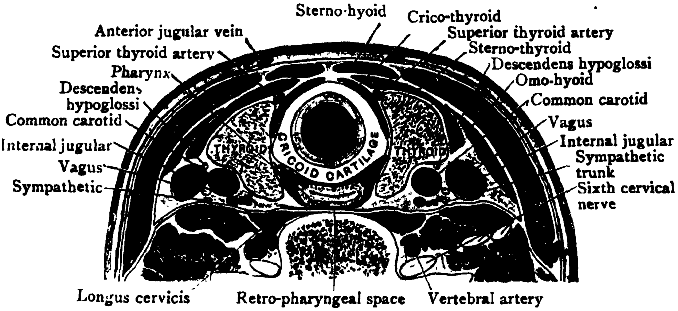


FIG. 86.—Transverse Section through the Neck at the level of the Cricoid Cartilage.

Posterior Relations.—The longus cervicis and longus capitis separate it from the cervical transverse processes. The sympathetic trunk lies lengthwise directly behind it, and the vagus is postero-lateral to it. The inferior thyroid artery crosses behind it, at the level of the cricoid cartilage; the vertebral artery lies between it and the transverse process of the seventh cervical vertebra; and at the root of the neck, the subclavian artery is postero-lateral to it. The recurrent laryngeal nerve crosses behind the *right* artery immediately above its origin ; and the thoracic duct turns laterally behind the *left* artery, between it and the vertebral artery.

Medial Relations.—The lower part of the artery is related medially to the trachea and œsophagus, and to the recurrent laryngeal nerve in the angle between them ; the upper part is related to the larynx and pharynx. The lobe of the thyroid gland lies either medial to the artery, separating it from the œsophagus, pharynx, trachea and larynx, or it forms a direct anterior relation (Figs. 86, 95).

Carotid Sinus and Carotid Body.—The upper part of the common carotid artery and the root of the internal carotid are slightly dilated (Fig. 87). The dilated part is called the *carotid sinus,* and is part of the mechanism that regulates blood-pressure. Distension of the sinus stimulates nerve-endings in its walls (which are more elastic than the adjacent parts of the arteries) and reflexly causes lowering of blood-pressure by vaso-dilatation. The *carotid body* is a small gland-like structure consisting of small cells arranged in clumps. It is placed on the deep surface of the carotid bifurcation; to expose it, twist the arteries round. It has been thought to be a gland of internal secretion. But it now seems that it is a specialised structure which responds to variations in the amount of CO_2 in the blood—increase of which excites it to cause reflex stimulation of respiration. The carotid sinus and body are both innervated by filaments of the glosso-pharyngeal nerve (" ramus caroticus ").

VESSELS AND NERVES IN UPPER PART OF NECK

If the parotid, infratemporal and submandibular regions have been dissected, the students will now continue the deeper dissection into the upper part of the neck. But if those regions have not been dissected, they will wrap up the neck carefully and pass to the parotid region, (p. 161), and will resume the dissection of the neck at this stage when they have completed the dissection of the submandibular region.

***Dissection.*—The *external carotid artery* and its branches have been partly or wholly dissected already. Identify the branches again, and clean such as have not been fully traced already. Lift up the sterno-mastoid and establish the continuity of the part of the *occipital artery* found in the carotid triangle with the part in the back of the neck. Push the posterior belly of the digastric out of the way, and clean the part of the external carotid artery which it conceals.**

External Carotid Artery.—The external carotid artery is one of the two terminal branches of the common carotid, and is named " external " because it is distributed to parts outside the skull.

It begins at the level of the upper border of the thyroid cartilage, runs upwards and backwards, and ends behind the neck of the mandible, opposite the lobule of the auricle, by dividing into the superficial temporal artery and the maxillary artery. Its lower part is anterior and medial to the internal carotid artery, and is comparatively superficial in the upper part of the carotid triangle; next, it passes under cover of the posterior belly of the digastric and the stylo-hyoid muscle

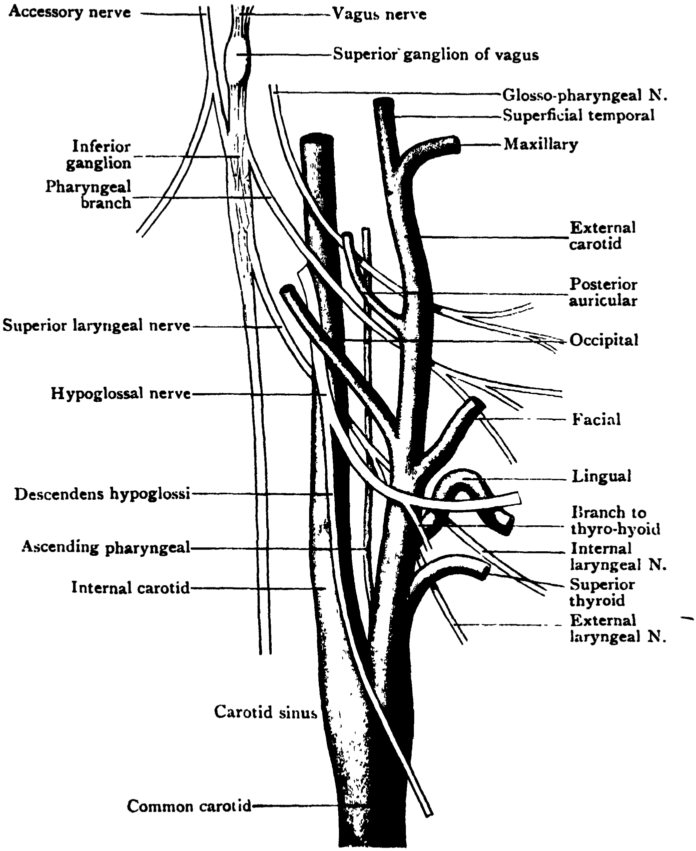


FIG. 87.—Diagram of Carotid System of Vessels in the Neck, with the Glosso-Pharyngeal, Vagus, Accessory, and Hypoglossal Nerves.

and the lower part of the parotid gland. At the upper border of the stylo-hyoid it enters a deep groove in the parotid; and leaves it to end between the gland and the neck of the mandible (Figs. 59, 88).

Superficial Relations.—As it lies in the carotid triangle, it is covered by the skin, superficial fascia and platysma, branches of the anterior cutaneous nerve of the neck and the cervical branch of the facial nerve, and the deep fascia. Beneath the deep fascia, it is crossed superficially by the common facial and lingual veins and the hypoglossal nerve; at the upper part of the triangle it is crossed, from behind forwards, by the anterior branch of the posterior facial vein, and may be overlapped by the lower end of the parotid gland. After it leaves the carotid triangle it is overlapped by the angle of the mandible, and is crossed by the posterior belly of the digastric and the stylo-hyoid. Within the parotid gland, the posterior facial vein is superficial to it, and both vessels are crossed by branches of the facial nerve.

Deep Relations.—In the carotid triangle, the pharynx is medial to it—with the external and internal laryngeal nerves intervening. The medial relations, at a higher level, will be seen to greater advantage at a later stage, when the styloid process is detached and displaced. They are the pharyngeal branch of the vagus, the stylo-pharyngeus, the glosso-pharyngeal nerve and the styloid process. Those structures lie to its medial side as they pass obliquely between it and the internal carotid, which has gradually attained a plane medial to that in which the external carotid lies, as well as posterior to it.

In the whole of its extent the external carotid is accompanied by numerous sympathetic nerve-fibres derived from the upper cervical sympathetic ganglion; they constitute the ***external carotid plexus***, which distributes offsets along all the branches of the artery.

BRANCHES OF EXTERNAL CAROTID ARTERY.—These are:—

1. Ascending pharyngeal	**from its medial side.**
2. Superior thyroid	**which pass forwards.**
3. Lingual	
4. Facial	
5. Occipital	**which pass backwards.**
6. Posterior auricular	
7. Maxillary	**terminal branches.**
8. Superficial temporal	

Several of these branches have been described already—

lingual, p. 202; *facial*, pp. 29, 193; *superficial temporal*, p. 18; *maxillary*, p. 173.

Superior Thyroid Artery.—This artery arises, within the carotid triangle, from the front of the external carotid close to its origin. It runs downwards and forwards, under cover of the omo-hyoid, sterno-hyoid and sterno-thyroid muscles, to the apex of the lobe of the thyroid gland, where it ends by breaking up into three terminal branches.

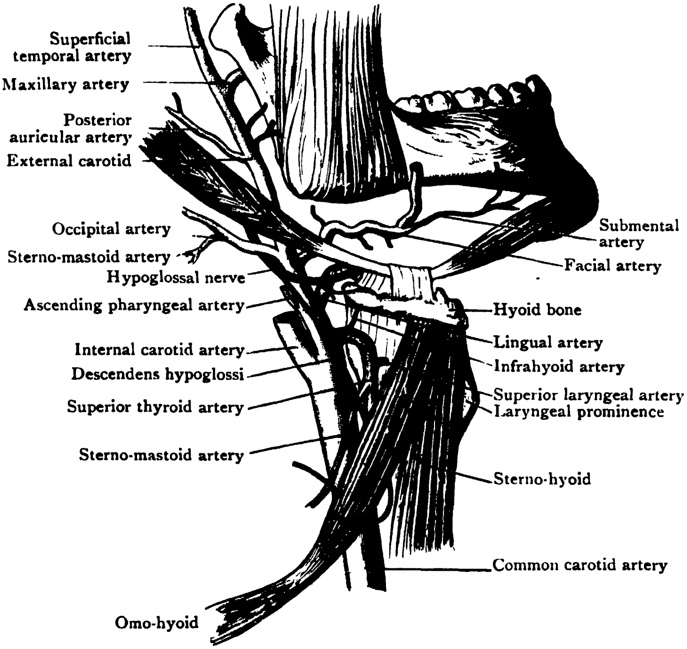


FIG. 88.—Diagram of the External Carotid Artery and its Branches. The right half of the mandible is tilted up.

The following branches proceed from it:—

1. Infrahyoid.
2. Superior laryngeal.
3. Sterno-mastoid.
4. Crico-thyroid.
5. Unnamed muscular.
6. Terminal glandular.

The *infrahyoid artery* is a small branch that runs along the lower border of the hyoid bone under cover of the thyrohyoid muscle.

The *superior laryngeal artery* is a larger vessel (Fig. 71). It arises near the infrahyoid branch, and, associating itself with the internal laryngeal nerve, it pierces the thyro-hyoid membrane, enters the pharynx, and descends to the larynx.

The *sterno-mastoid branch* is a small vessel which runs downwards and backwards across the carotid sheath, along the upper border of the superior belly of the omo-hyoid muscle, to reach the deep surface of the sterno-mastoid muscle. It is only a muscular branch, but is singled out for mention because it is a superficial relation of the common carotid artery.

The *crico-thyroid artery* is a slender branch that arises under cover of the sterno-thyroid muscle. It runs medially across the crico-thyroid muscle on to the crico-thyroid membrane, where it anastomoses with its fellow. It sometimes arises before the parent artery reaches the sterno-thyroid; it may then run superficial to the insertion of the sterno-thyroid.

The *glandular branches* supply the thyroid gland.

Occipital Artery.—The occipital artery springs from the back of the external carotid artery at the same level as the facial. It takes the lower border of the posterior belly of the digastric muscle as its guide, and runs upwards and backwards under cover of the sterno-mastoid muscle and, generally under cover of the lower border of the posterior belly of the digastric, to reach the interval between the mastoid portion of the base of the skull and the transverse process of the atlas. Its further course has been seen in the back of the neck and the scalp (pp. 69, 19).

The first part of the vessel crosses the internal carotid artery, the hypoglossal nerve (which hooks round it), the accessory nerve and the internal jugular vein (Fig. 59).

The branches given off by the occipital artery in this region are:—(1) muscular twigs; and (2) a meningeal branch.

The *muscular twigs* are given to the neighbouring muscles. The *sterno-mastaid branches* are the most constant. One of these arises as the hypoglossal nerve hooks round the artery; the other arises higher up and accompanies the accessory nerve.

A *meningeal branch* runs up on the surface of the internal jugular vein, and enters the skull through the jugular foramen.

Posterior Auricular Artery.—This small artery arises from the back of the external carotid above the level of the posterior belly of the digastric. In the first part of its course it is placed deeply, and runs upwards and backwards, between the styloid process and the parotid gland, to reach the interval between the mastoid process and the back of the auricle. It then accompanies the posterior auricular nerve (p. 17).

Besides twigs to muscles and to the parotid gland, it gives off the *stylo-mastoid artery*, which enters the stylo-mastoid foramen to be distributed in the interior of the temporal bone.

Dissection.—Divide the posterior belly of the digastric immediately below its origin, and turn it downwards and forwards; then, clean the _stylo-pharyngeus muscle_, taking care of the _glosso-pharyngeal nerve_, which turns round its posterior border. If necessary, in order to get at deeper parts, cut the occipital and posterior auricular arteries, but do not do so unless it is unavoidable.

Pass to the posterior part of the thyro-hyoid interval, define the margins of the middle and inferior constrictors; remove the fascia from the interval between these margins, and expose and clean a further piece of the stylo-pharyngeus.

Stylo-Pharyngeus.—This is the longest of the three muscles that spring from the styloid process. It arises from the medial surface of the process close to its root, and extends downwards and forwards between the external and internal carotid arteries to gain the side of the pharynx, where it disappears under cover of the upper border of the middle constrictor muscle. Its fibres blend with those of the palato-pharyngeus under cover of the middle constrictor, and the two muscles are inserted into the posterior border of the lamina of the thyroid cartilage. It is supplied by the glosso-pharyngeal nerve. It lifts up the larynx during phonation and swallowing.

Dissection.—Snip through the base of the styloid process with the bone-forceps, and throw it and the attached muscles downwards and forwards. The upper parts of the internal carotid artery and internal jugular vein are now exposed.

Pull the internal carotid backwards and push the external carotid forwards. If small arteries are well injected, the _ascending pharyngeal artery_ will be seen on the side of the pharynx. Follow it to the base of the skull, and clean also the upper part of the _ascending palatine artery_, which is described on p. 193.

Ascending Pharyngeal Artery.—This is the first and the smallest branch of the external carotid, and springs from its medial side near its lower end. It runs upwards along the side of the pharynx hidden under cover of the carotid arteries.

Its branches are:—(1) *pharyngeal*, to pharynx, pharyngo-tympanic tube, tonsil and palate; (2) *muscular*, to prevertebral muscles; (3) *inferior tympanic*, which accompanies the tympanic branch of the glosso-pharyngeal nerve to the middle ear; (4) *meningeal*, which enter the skull through the foramen lacerum, jugular foramen and anterior condylar canal.

LARGE VESSELS AND NERVES AT BASE OF SKULL.—The upper parts of the internal jugular vein and internal carotid artery have now to be cleaned, and also the last four cranial nerves after their emergence from the skull. It is a difficult dissection, for these structures are enclosed in dense, tough fascia, and it takes both care and patience to trace the nerves and their branches through it. Before beginning, look at the lower surface of the base of a skull and note the relative position of the three openings that transmit those structures —the *carotid canal*, the *jugular foramen* and the *anterior condylar canal* (hypoglossal canal). The internal carotid artery ascends into the carotid canal; the jugular foramen is behind the canal, and transmits the internal jugular vein and three nerves in front of the vein—glosso-pharyngeal, vagus and accessory. The anterior condylar canal is medial to the jugular foramen. The hypoglossal nerve emerges through it, approaches the other nerves, and twists round the vagus—adhering to it. All four nerves are therefore close together, between the artery and the vein, near the base of the skull. They soon choose different routes. The accessory inclines backwards, either superficial or deep to the internal jugular vein. The glosso-pharyngeal inclines forwards, superficial to the internal carotid. The hypoglossal, at a lower level, curves forwards across the internal and external carotid arteries. The vagus descends vertically between the internal carotid artery and the internal jugular vein.

Dissection.—**The *internal laryngeal nerve* has been dissected already. Find it again. Trace it upwards to its origin from the *superior laryngeal nerve*, and trace that nerve up to its origin from the vagus. As you do so, keep a careful look out for the *pharyngeal branch of the vagus*. It is very liable to injury. It arises near the laryngeal nerve, and passes downwards and medially across the internal carotid to reach the pharynx.**

The *glosso-pharyngeal* has been found already as it crossed the stylo-pharyngeus. Trace it upwards. Deal likewise with the *hypoglossal* and *accessory* nerves. Separate the nerves from one another, and look for communicating branches that connect them with one another and with the sympathetic trunk and the first cervical nerve, which lies behind the internal jugular vein. The vein, however, may be left undisturbed in the meantime.

Pass to the *internal carotid artery*. Clean it. Lift it up and find the *sympathetic trunk* behind it. Identify the *superior cervical ganglion* of that trunk; it is a spindle-shaped body about an inch long; look for slender branches that pass laterally from it to reach the upper cervical nerves behind the internal jugular vein.

Define the margins of a prevertebral muscle, called the *longus capitis*, on which both artery and trunk lie.

Internal Carotid Artery.—The internal carotid artery is one of the two terminal branches of the common carotid, and it begins, therefore, at the level of the upper border of the thyroid cartilage. From that point it proceeds almost vertically upwards to the base of the skull; there, it disappears from view by entering the carotid canal, through which it reaches the interior of the cranium. The cervical part alone comes under notice in the present dissection.

Relations.—*Posterior* to the internal carotid, there are the longus capitis and the sympathetic trunk. The vagus is postero-lateral; and so also are the glosso-pharyngeal, accessory and hypoglossal, near the base of the skull.

The internal jugular vein is *lateral*, except near the skull where it becomes posterior. *Medially*, the internal carotid is related to the constrictors of the pharynx, the ascending pharyngeal artery and the levator palati muscle.

The structures that are *superficial* to it are very numerous. In the first part of its extent, it lies in the carotid triangle, and is therefore fairly near the surface. It is covered by the skin, platysma and fasciæ, and is overlapped by the sterno-mastoid muscle. It is crossed by the lingual and common facial veins, the occipital artery and its lower sterno-mastoid branch, and by the hypoglossal nerve. The descendens hypoglossi descends on its superficial surface.

As it proceeds upwards, it passes under cover of the posterior belly of the digastric, the stylo-hyoid, the stylopharyngeus and the styloid process, which separate it from the parotid gland. Note that *three nerves* and *three arteries* cross the vessel superficially, viz. :—

1. The hypoglossal nerve.	1. The lower sterno-mastoid branch of the occipital artery.
2. The pharyngeal branch of the vagus nerve.	2. The occipital artery.
3. The glosso-pharyngeal nerve.	3. The posterior auricular artery.

The hypoglossal nerve, as already noted, crosses it in the carotid triangle; the other nerves cross it under cover of the posterior belly of the digastric. The sterno-mastoid artery crosses it at the point where the hypoglossal nerve turns forwards; the occipital artery at the level of the lower border of the posterior belly of the digastric ; and the posterior auricular, at the level of the upper border of that muscle.

The relationship of the external carotid artery to the internal carotid is a varying one. At first the external carotid is antero-medial to the internal carotid ; but it inclines backwards and soon comes to lie superficial to the internal carotid. The following structures intervene between the two vessels :—

1. Styloid process.
2. Stylo-pharyngeus muscle.
3. Glosso-pharyngeal nerve.
4. Pharyngeal branch of vagus.
5. A portion of the parotid gland.

Glosso-Pharyngeal Nerve.—The ninth cranial nerve is a mixed nerve. Its *motor* fibres supply the stylo-pharyngeus ; its *sensory* fibres supply the mucous membrane of the middle ear, the pharynx and posterior third of the tongue and also the carotid sinus and carotid body ; its *secretory* fibres reach the parotid gland by a circuitous route. The motor and secretory fibres arise in the medulla oblongata. The sensory fibres arise in two small *ganglia* placed on the trunk of the nerve in the jugular foramen, and their central branches end in the medulla oblongata.

Course and Relations.—The nerve is attached to the side of the upper end of the medulla oblongata. It leaves the skull through a notch on the margin of the jugular foramen below the internal auditory meatus—enclosed in its own sheath of dura mater ; and, while in the jugular foramen, it communicates with neighbouring nerves. In the neck, it first descends between the internal jugular vein and the internal carotid artery, deep to the styloid process and the stylo-pharyngeus. Next, appearing at the posterior border of the stylo-pharyngeus, it passes, with that muscle, between the internal and external carotid arteries ; at the same time it curves forwards across the superficial surface of the stylo-pharyngeus ; and it then runs onwards over the side of the pharynx to disappear under cover of the hyo-glossus, where it breaks up into terminal branches for the tongue, the tonsil, the soft palate and the epiglottis.

Branches.—Besides the *communicating* and the *terminal* branches, it gives off the tympanic nerve, the stylo-pharyngeal branch and pharyngeal branches.

The *tympanic nerve* is a very slender nerve that arises immediately below the skull. It enters a small hole on the ridge between the carotid canal and jugular fossa, and ascends through a narrow canal to the tympanum. On the medial wall of the tympanum it breaks up to form the *tympanic plexus*. The plexus is joined by two minute *carotico-tympanic nerves* which arise in the carotid canal from the sympathetic plexus around the internal carotid artery. The tympanic plexus supplies the mucous membrane of the tympanum, the pharyngo-tympanic tube, the tympanic antrum and the mastoid air-cells ; and its sends a root to the lesser superficial petrosal nerve by which the secretory fibres are sent on the first stage of their course to the parotid gland.

The *nerve to the stylo-pharyngeus* is a small twig which enters that muscle; the greater part of its fibres, however, are continued through the muscle to the mucous membrane of the pharynx.

The *pharyngeal branches* are:—(1) One or two small twigs which perforate the superior constrictor to reach the mucous membrane of the pharynx. (2) A larger nerve which comes off higher up and passes with the pharyngeal branch of the vagus to the pharyngeal plexus ; it divides into two or more branches, one of which sends filaments to the carotid sinus and carotid body (" ramus caroticus ").

Vagus Nerve.—The tenth cranial nerve is a mixed nerve ; and, as its name " vagus " implies, it goes far afield, supplying structures from the inside of the skull to the abdomen. Its *motor* fibres supply the heart, the respiratory system and a great part of the digestive system ; its *secretory* fibres supply the glands in the alimentary canal, the liver, the pancreas and the kidney ; its *sensory* fibres supply a part of the dura mater, a part of the skin of the external auditory meatus, and the lining membranes of the respiratory and digestive systems. The efferent fibres (motor and secretory) arise in the medulla oblongata. There are two *ganglia* on the trunk of the nerve—one in the jugular foramen, and one immediately below the skull. The afferent (sensory) fibres arise in these ganglia; and their central branches end in the medulla oblongata.

Course and Relations.—The vagus is attached by a vertical row of roots to the side of the medulla oblongata. It passes through the middle compartment of the jugular foramen in company with the accessory nerve—both being included within the same sheath of dura mater. In the neck, it pursues a vertical course, lying, at first, between the internal jugular vein and the internal carotid artery, and afterwards between the same vein and the common carotid artery, enclosed within the fascial sheath which envelops the vessels, but on a plane posterior to them. It has, therefore, practically the same relations as those vessels. At the root of the neck, the *right vagus* crosses in front of the subclavian artery, and then passes downwards and medially in the fat behind the innominate vessels to reach the right side of the trachea in the thorax. The *left vagus* descends in front of the subclavian artery, and enters the thorax between the common carotid artery and the ascending part of the subclavian artery, behind the left innominate vein.

Branches.—Numerous *communicating twigs* pass between the vagus and other nerves in the jugular foramen and below the base of the skull. The *branches of distribution* that arise in the head and neck are:—meningeal; auricular; pharyngeal; superior laryngeal; cardiac; and, on the right side, recurrent laryngeal. As the vagus leaves the skull it is joined by the cranial part of the accessory nerve—*i.e.* the fibres that arise in the medulla oblongata—and these fibres pass into the pharyngeal, laryngeal and cardiac branches.

The *meningeal branch* is a minute twig that arises in the jugular foramen and runs upwards to supply the dura mater in the posterior cranial fossa.

The *auricular branch* is a slender (but not unimportant) filament that arises in the jugular foramen. It enters a small hole in the lateral wall of the jugular fossa, whence a tiny, horizontal canal conducts it to the tympano-mastoid fissure. It supplies the skin on the back of the external auditory meatus, and then pierces the cartilage of the meatus to supply the cutaneous lining of the lower half of the meatus and of the lower half of the tympanic membrane.

The *pharyngeal branch* arises immediately below the skull. It passes downwards and forwards between the internal and external carotid arteries to the side of the pharynx, where it forms a large part of the pharyngeal plexus. It may be represented by two branches. The *pharyngeal plexus* is a meshwork of fine nerve-filaments that lies on the side of the pharynx in the fascia that covers the middle constrictor. It is formed of the pharyngeal branches of the vagus, glosso-pharyngeal, and superior cervical ganglion of the sympathetic trunk. It contains a few minute ganglia. Its branches supply the muscles and mucous membrane of the pharynx; and it sends a communicating branch to the hypoglossal nerve.

The *superior laryngeal nerve* arises below the pharyngeal branch, and is much larger than that branch. It passes downwards and forwards deep to the internal carotid artery, and soon divides into the internal and external laryngeal nerves, which have been seen already in the carotid triangle.

The *internal laryngeal nerve* runs downwards and forwards on the side of the pharynx, deep to the carotid arteries; and then, passing off the middle constrictor, it reaches the thyro-hyoid membrane, where it is joined by the superior laryngeal artery. Together, they slip under the posterior border of the thyro-hyoid muscle, pierce the membrane, and run downwards between the membrane and the mucous lining of the pharynx to reach the larynx, where the nerve supplies the mucous lining down to the level of the vocal fold.

The *external laryngeal nerve* is very slender. It gives branches to the inferior constrictor and ends in the crico-thyroid muscle. It runs downwards on the side of the pharynx deep to the carotid and superior thyroid arteries; and, passing under cover of the sterno-thyroid muscle and thyroid gland, it slips off the inferior constrictor to enter the crico-thyroid—which is the only intrinsic laryngeal muscle that lies on the outside of the larynx and the only one not supplied by the recurrent laryngeal nerve.

The *cardiac branches* that arise from the vagus in the neck are two soft, slender filaments seldom found unless unusual care is exercised. One arises in the upper part of the neck and one in the lower—the points of origin being inconstant. They descend with the vagus to the root of the neck. Those of the left side enter the thorax with the vagus. Those of the right side pass behind the subclavian artery to reach the thorax.

The *recurrent laryngeal nerve* arises differently on the two sides. The *right* nerve arises as the vagus crosses the first part of the subclavian artery; it hooks round the subclavian artery and passes behind the common carotid to reach the groove between the trachea and œsophagus. The *left* nerve arises in the thorax as the vagus crosses the arch of the aorta; it hooks round the arch to reach the groove.

In the neck, each recurrent nerve ascends in the groove between the trachea and œsophagus, along the medial side of the lobe of the thyroid gland, and, passing posterior or anterior to the inferior thyroid artery, it disappears under cover of the lower border of the inferior constrictor muscle, and enters the larynx.

Before the recurrent nerve reaches the larynx it gives off several branches:—(1) Cardiac branches arise near its origin; (2) twigs to the trachea and œsophagus arise as it ascends between them; and (3) a few filaments are given to the inferior constrictor as it passes under cover of its lower margin. In the larynx, it supplies (*a*) all its intrinsic muscles except the crico-thyroid, and (*b*) the mucous membrane below the level of the vocal fold.

Accessory Nerve.—The eleventh cranial nerve is purely motor. It has two roots—a cranial and a spinal. The fibres of the *cranial root* arise in the medulla oblongata, emerge through its side as a vertical row of bundles below the vagus, in line with the posterior roots of cervical nerves; and they unite to form one stem. The fibres of the *spinal root* arise from the upper five cervical segments of the spinal cord. They emerge through the side of the cord as a row of bundles between the anterior and posterior roots of the upper cervical nerves. The row inclines backwards as it is traced upwards, and, at the upper end of the spinal cord, is very near the posterior root of the first cervical nerve. The bundles unite to form one or two cords which ascend through the foramen magnum, and join the cranial root.

Course, Relations and Termination.—The united trunk descends through the jugular foramen in the same sheath of dura mater as the vagus. As the nerves leave the foramen, the two parts of the accessory nerve separate. The *cranial part* unites with the vagus and is distributed by its pharyngeal, laryngeal and cardiac branches.

The *spinal part* is the portion of the nerve encountered in the neck, and it supplies two muscles—the sterno-mastoid and the trapezius. It descends between the internal jugular vein and internal carotid artery, under cover of the styloid process and the posterior belly of the digastric, till it reaches a point about midway between the mastoid process and the angle of the mandible. It then inclines backwards across the upper angle of the carotid triangle, deep to the occipital artery and usually superficial to the internal jugular vein, and sinks into the sterno-mastoid muscle. After supplying the sterno-mastoid, it emerges from the middle of its posterior border and then slants across the posterior triangle in the deep fascia of its roof to disappear under the trapezius, in which it ends.

Hypoglossal Nerve.—The twelfth cranial nerve also is purely motor. It supplies the stylo-glossus, hyo-glossus, genio-glossus and the intrinsic muscles of the tongue. Certain of its branches supply other muscles—the genio-hyoid and the infra-hyoid muscles—but the fibres of those branches are brought into the hypoglossal nerve in the neck by a communicating branch from the first cervical nerve.

Origin and Course.—The proper fibres of the hypoglossal nerve arise in the medulla oblongata. They emerge through the front of it as a row of rootlets which unite to form two roots. The two roots pass laterally, pierce the dura mater separately, enter the anterior condylar canal and unite at its external orifice to form the stem of the nerve, which descends into the neck.

Examine the lower surface of the base of a skull. Identify the anterior condylar canal, occipital condyle, jugular fossa and carotid canal, and note the position of the nerve as it begins to descend into the neck. It is close to the lateral side of the joint between the atlas and the condyle (and is therefore liable to attack from disease of that joint); it is medial to the internal carotid artery and to the internal jugular vein and the three nerves that descend through the jugular foramen. But very soon it inclines laterally towards those two vessels, and, making a half-spiral twist round the vagus, it descends between the artery and the vein, under cover of the styloid process and the posterior belly of the digastric. At the lower border of the digastric it enters the anterior triangle of the neck; and its further course has been studied already (pp. 158, 201).

Branches.—(1) A *meningeal branch* (composed of fibres from C.1) arises in the anterior condylar canal and runs inwards to supply the dura mater around the foramen magnum. (2) Descendens hypoglossi (p. 158). (3) The nerve to the thyro-hyoid (p. 158). (4) A branch to the genio-hyoid. (5) Branches to the stylo-glossus, hyo-glossus and genio-glossus —*i.e.* to all the extrinsic muscles of the tongue except the palato-glossus (which is supplied through the pharyngeal plexus by fibres of the accessory). (6) Terminal branches to the intrinsic muscles of the tongue.

The hypoglossal nerve communicates with other nerves. The largest of these is a branch which enters it from the first cervical nerve. The fibres of that nerve form the meningeal and descendens branches and the nerves to the thyro-hyoid and genio-hyoid.

> ***Dissection.***—**The sympathetic trunk has been displayed already. Find the *inferior cervical ganglion* again. Push the vertebral artery laterally, display the ganglion more fully, and clean the branches that spring from it.**

Sympathetic Trunk.—The sympathetic trunk lies nearly vertically in the neck, medial to the vagus, behind the common and internal carotid arteries, on the longus cervicis and longus capitis muscles, opposite the roots of the transverse processes. Its lower part is close to the medial side of the vertebral artery. The inferior thyroid artery crosses it at the level of the cricoid cartilage; usually the artery passes medially behind the trunk, but sometimes in front of it or may even pass through it. A little lower down, the thoracic duct passes laterally across the front of the left trunk.

The trunk ends superiorly in the superior cervical ganglion —its continuation into the skull being called the internal carotid nerve. Inferiorly, it descends across the front of the neck of the first rib into the thorax.

Ganglia and Rami Communicantes.—Three ganglia are developed on the trunk in the neck—superior, middle and inferior. The ganglia send grey rami communicantes to the anterior primary rami of all the cervical nerves, but, unlike the thoracic ganglia of the trunk, they receive no white rami from the spinal nerves. There is considerable variability in the number of grey rami and in the number of cervical nerves connected with each ganglion; but the arrangement usually described is that the superior ganglion is connected with the upper four cervical nerves, the middle ganglion with the fifth and sixth, and the inferior ganglion with the seventh and eighth. The grey rami may pass by the easiest route—between muscles—to reach the cervical nerves, or they may pierce the longus muscles or the scalenus anterior.

Superior Cervical Ganglion.—This is the largest ganglion of the trunk. It lies between the internal carotid artery and the longus capitis, opposite the second and third cervical vertebræ. It is about an inch long and is spindle-shaped—its lower end tapering into the trunk, its upper end tapering into its internal carotid branch. It has numerous branches :—

(1) Communicating twigs connect it with the ninth, tenth and twelfth cranial nerves.

(2) *Grey rami communicantes* pass laterally behind the vagus to join the upper four cervical nerves behind the internal jugular vein.

(3) The *internal carotid nerve* passes upwards with the artery and breaks up to form the *internal carotid plexus* around it.

(4) The *pharyngeal branch* (or branches) passes medially to the side of the pharynx, communicates with the superior laryngeal nerve, and joins the pharyngeal plexus (p. 236).

(5) The *external carotid nerves* run to the external carotid artery and form a plexus around it which sends secondary plexuses along its branches.

(6) The *cardiac branch* is a long slender nerve. On the left side, it runs down along the common carotid artery into the thorax and ends in the superficial cardiac plexus. On the right side it descends along the common carotid to the root of the neck, and then, passing either in front of the subclavian artery or behind it, it runs in the fat behind the innominate artery to reach the trachea in the thorax ; and it ends in the deep cardiac plexus.

Middle Cervical Ganglion.—This ganglion is very small. It lies on the inferior thyroid artery, behind the common carotid, at the level of the cricoid cartilage. Its branches are :—

(1) *Grey rami communicantes* pass laterally and backwards between the slips of origin of the longus capitis and scalenus anterior to join the fifth and sixth cervical nerves.

(2) *Thyroid branches* accompany the inferior thyroid artery to the thyroid gland, and communicate with the external and recurrent laryngeal nerves.

(3) The *cardiac branch* is a slender nerve that ends in the deep cardiac plexus. On the right side, it accompanies the superior cardiac nerve ; on the left side, it runs down between the subclavian and common carotid arteries to reach the trachea.

(4) The *ansa subclavia* is a slender cord that descends to the front of the subclavian artery, loops round the artery and

The branches of the inferior cervical ganglion are :—

(1) *Grey rami communicantes* pass backwards to join the seventh and eighth cervical nerves above and below the seventh transverse process ; or they may run laterally to the scalenus anterior and pierce it before they join the nerves.

(2) Fine filaments join branches of the ansa subclavia to form a *subclavian plexus* around the subclavian artery.

(3) Larger filaments form a *vertebral plexus* around the vertebral artery.

(4) A *cardiac branch* accompanies the middle cardiac nerve to the deep cardiac plexus.

Dissection.—**Clean the upper part of the *internal jugular vein*. Then, push the vein medially, and find the *rectus capitis lateralis* behind the vein, between the skull and the atlas. Clean the muscle and define its margins. At its medial margin, secure a slender nerve—the *anterior ramus of the first cervical nerve*. Trace that nerve downwards to its union with the *second nerve* ; then, trace the second to the *third*, and the third to the *fourth*, and find the small branch that descends from the fourth to the *fifth*.**

Clean all those nerves carefully, and secure their branches ; and then define the attachments of the scalene muscles to the transverse processes. Finally, trace the lower cervical nerves and the first thoracic nerve as far medially as possible, displacing the scalenus anterior first medially and then laterally.

Internal Jugular Vein.—This large vessel is the widest of the jugular veins, and is the longest vein in the neck. It begins in the jugular foramen as the continuation of the sigmoid sinus (which is continuous with the transverse sinus) ; it descends vertically in the neck along the lateral side of the internal and common carotid arteries, enclosed with them and the vagus in the carotid sheath of fascia ; it ends behind the medial part of the clavicle by uniting with the subclavian vein to form the innominate vein. In the lower part of the neck, both veins trend to the right. The left vein therefore overlaps the common carotid considerably, while the right vein recedes from it.

Its commencement shows a considerable dilatation called the *upper bulb* of the jugular vein. The bulb is accommodated in the jugular fossa of the skull, and its lumen is always patent because its walls are adherent to the margins of the fossa. At or near the lower end of the vein there is a valve of two or of three cusps. Immediately above the valve, there is a smaller dilatation called the *lower bulb*, which is opposite the hollow between the two heads of the sterno-mastoid muscle near the clavicle.

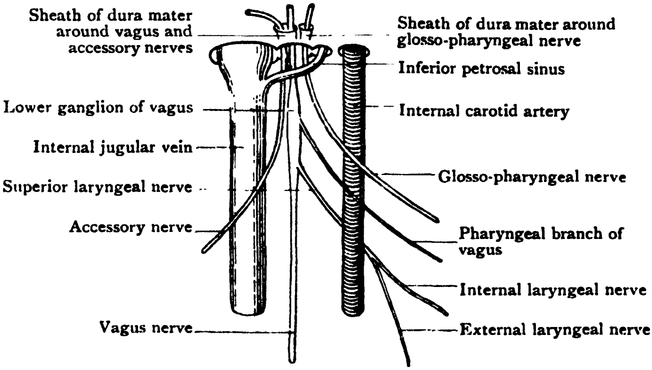


FIG. 89.—Diagram of relation of parts in Right Jugular Foramen.

The right and left internal jugular veins are seldom of equal width—the right being usually the wider. Examine the inside of a skull. Compare the transverse and sigmoid grooves of the two sides. The groove is wider on the side to which the superior sagittal sinus turns ; and, on that side, the jugular foramen, fossa, vein and bulb are all wider than on the other. Look at the lower surface of the base, and, from the jugular fossa, gauge the size and position of the bulb ; and note its relations to surrounding parts—carotid and anterior condylar canals, occipital condyle, jugular and styloid processes, stylomastoid foramen and external auditory meatus.

Relations.—At its upper end, the vein is postero-lateral to the internal carotid, and is partly separated from it by the last four cranial nerves. As it descends, it assumes a more direct lateral relationship first to the internal carotid and then to the common carotid, and slightly overlaps them anteriorly. The vagus is still between the vein and the arteries, but rather on a posterior plane.

The *superficial relations* of the vein in the upper part of its extent are the styloid process, with the stylo-pharyngeus and stylo-hyoid muscles, and the posterior belly of the digastric, which separate it from the upper part of the parotid gland. In that part of its extent it is crossed superficially by two arteries and a nerve. They are:—the posterior auricular artery, running backwards and upwards along the upper border of the posterior belly; the occipital artery, running backwards and upwards along the lower border of the muscle or under cover of it; and the accessory nerve, running downwards and backwards deep to the muscle and the arteries. At a slightly lower level it is crossed by a sterno-mastoid branch of the occipital artery. After escaping from the parotid and digastric, at the upper angle of the carotid triangle, it disappears almost at once under cover of the sterno-mastoid.

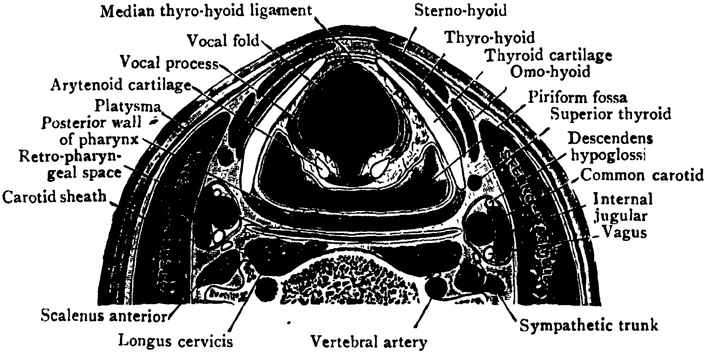


FIG. 90.—Transverse Section through the Neck at the level of upper part of Thyroid Cartilage.

It is, however, separated from the sterno-mastoid by a number of structures:—(1) Numerous lymph-glands along its whole course. (2) The descendens cervicalis nerve, at the level of the thyroid cartilage. (3) The sterno-mastoid branch of the superior thyroid artery, the intermediate tendon of the omo-hyoid, and the nerve to the inferior belly of the omo-hyoid, at the level of the cricoid. (4) In its lower part, the anterior jugular vein, the sterno-hyoid and the sterno-thyroid muscles.

Posteriorly, it lies first on the rectus capitis lateralis; next, on the transverse processes, the muscles attached to them, the cervical plexus and its branches, the ascending cervical artery and the anterior vertebral vein; at a lower level, on the thyro-cervical trunk and its branches—overlapping the phrenic nerve and the scalenus anterior; and, finally, it lies on the vertebral vein, the subclavian artery and the pleura. The thoracic duct crosses behind the left vein in the root of the neck.

Tributaries.—(1) The *inferior petrosal sinus* joins it at the jugular foramen; (2) two or more *pharyngeal veins* from the plexus on the side of the pharynx pass either superficial or deep to the internal carotid artery and join it in the upper part of the neck; (3) the *common facial*, (4) the *lingual* and (5) the *superior thyroid* join it in the carotid triangle; (6) the *middle thyroid vein* joins it in the root of the neck; (7) it may receive the *jugular lymph-trunk* (p. 221).

Cervical Plexus.—The cervical plexus is formed by the anterior primary rami of the upper four cervical nerves. It is situated in the upper part of the neck opposite a line drawn down the side of the neck from the root of the auricle to the level of the upper border of the thyroid cartilage. It lies behind the internal jugular vein and the deep fascia, on the front of the transverse process of the atlas and on the scalenus medius muscle.

The four nerves concerned in the formation of the plexus appear above the corresponding vertebræ, and they increase in thickness from above downwards.

The anterior primary ramus of the first cervical appears at the medial margin of the rectus lateralis, descends over the front of the transverse process of the atlas and joins the second. The combined first and second pass downwards and laterally to join the third on the front of the scalenus medius; and a communicating loop connects the third with the fourth. A slender branch that descends from the fourth to the fifth connects the cervical plexus with the brachial.

Branches.—They are communicating, cutaneous, and muscular.

The *communicating branches* are:—(1) The grey rami communicantes which the anterior primary rami of the upper four cervical nerves receive from the superior cervical ganglion. (2) A communicating branch from the first cervical to the hypoglossal. (3) Communicating branches from the second, third and fourth to the accessory.

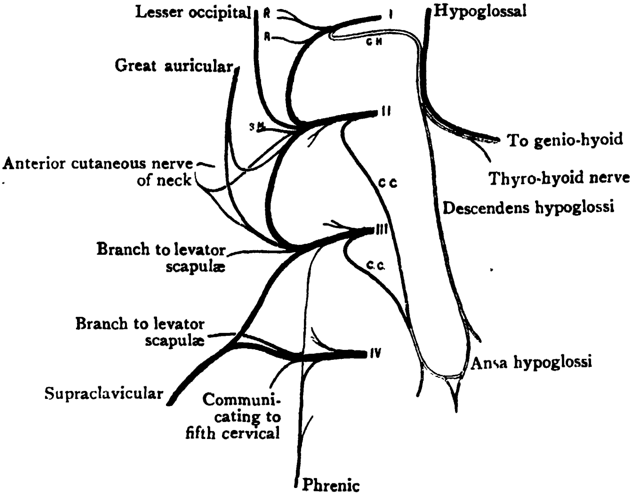


FIG. 91.—Diagram of the Cervical Plexus and the Ansa Hypoglossi.

I, II, III, IV.—Anterior Primary Rami of the upper four cervical nerves.

R. Branches to recti and longus capitis.
S.M. Branch to the sterno-mastoid.
C.C. Roots of descendens cervicalis.
C.H. Communicating to hypoglossal.

Note that the descendens hypoglossi and the nerves to the thyro-hyoid and genio-hyoid are derived from the communicating branch that passes from the first cervical to the hypoglossal.

The *cutaneous branches* are described on pp. 46-48. They are the lesser occipital, great auricular, anterior cutaneous, and supraclavicular.

The *muscular branches* are the phrenic, the descendens cervicalis, and numerous branches which are distributed to the rectus capitis lateralis, the prevertebral, scalene, and intertransverse muscles, the levator scapulæ, the sterno-mastoid and the trapezius. The phrenic nerve is the most important branch of the plexus since it is the nerve of supply to the chief muscle of respiration—the diaphragm.

Phrenic Nerve.—The nerve of the diaphragm arises chiefly from the **fourth** cervical nerve, and additional roots spring from the third and the fifth.

It begins on the scalenus medius at the lateral margin of the scalenus anterior, under cover of the sterno-mastoid, at the level of the upper border of the thyroid cartilage. It passes on to the scalenus anterior at once, and descends over the front of it between the muscular substance and the fascial covering—crossing the muscle from lateral to medial border. At the root of the neck, the *right* nerve passes off the scalenus anterior on to the pleura behind the innominate vein, and enters the thorax. The *left* nerve leaves the scalenus anterior at a higher level and descends in front of the first part of the subclavian artery into the thorax.

As the nerve lies on the scalenus anterior, it is under cover of the sterno-mastoid, at the lateral side of the internal jugular vein, and is overlapped by the vein. It is crossed by the inferior belly of the omo-hyoid, and the transverse cervical and suprascapular arteries (in that order from above downwards); the left nerve is crossed also by the thoracic duct; but all those structures are separated from the nerve by a thin but strong sheet of fascia. As the right nerve lies behind the innominate vein, it crosses the internal mammary artery from lateral to medial side, usually in front of the artery.

The root from the fifth cervical nerve usually joins the phrenic trunk on the surface of the scalenus anterior, but it may descend into the thorax before it effects a junction—a point that has to be kept in mind in operations on the phrenic nerve. And this root may arise not directly from the fifth nerve but from the nerve to the subclavius.

The **descendens cervicalis nerve** (from the second and third) is described on p. 158, and the *branches to the levator scapulæ* and *to the trapezius* (from the third and fourth) are described on p. 53.

Twigs from the first nerve pass to the *rectus capitis anterior* and *lateralis*; from the upper four to the *longus capitis*; from the second to the *sterno-mastoid*; from all except the first to the *intertransverse muscles;* and the *longus cervicis* and the *scalene muscles* receive irregular branches from the lower six.

The dissectors will now examine the rectus lateralis and the scalene muscles.

Rectus Capitis Lateralis.—This small muscle arises from the transverse process of the atlas and passes upwards to be inserted into the jugular process of the occipital bone—*i.e.* the part immediately behind the jugular foramen. The internal jugular vein lies on its anterior surface, and the obliquus capitis superior on its posterior surface. The occipital artery and the posterior belly of the digastric are related to its lateral border, and the vertebral artery and the anterior ramus of the first cervical nerve to its medial border. It is supplied by that nerve; and it tilts the head to its own side.

SCALENE MUSCLES.—The scalene muscles constitute the thick fleshy mass that extends from the cervical transverse processes to the upper two ribs. They are three in number, and are named, from their relative positions, *anterior*, *medius*, and *posterior*.

They are supplied by twigs from the anterior primary rami of *the lower five or six cervical nerves*. Acting from below, they bend the neck sidewards and forwards; acting from above, they elevate the first two ribs in forced inspiration.

Scalenus Anterior.—This is a well-defined muscle which is separated from the scalenus medius by the roots of the brachial plexus and the subclavian artery. It arises from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ, and, tapering slightly as it descends, it is inserted into the scalene tubercle and upper surface of the first rib between the grooves for the subclavian artery and vein (Fig. 92).

Relations.—The scalenus anterior is related to a large number of structures in the root of the neck, and, as the muscle is easily recognised, it is a guide to them.

The upper part of its *anterior surface* is concealed by the sterno-mastoid, and the lower part by the clavicle. The common carotid artery ascends along its medial border. Between it and the sterno-mastoid there are:—(1) the internal jugular vein; (2) the inferior belly of the omo-hyoid; (3) the phrenic nerve; (4) the transverse cervical and suprascapular arteries, passing backwards and laterally, superficial to the phrenic nerve; and (5) the anterior jugular vein. The subclavian vein lies between it and the clavicle.

Its *posterior surface* is in relation, above, with the tips of the lower cervical transverse processes, and below, with the apex of the pleura, the second part of the subclavian artery, and its costo-cervical branch. The *lateral border* touches the roots of the brachial plexus; and the *medial border* is in relation with the thyro-cervical trunk, the inferior thyroid artery and its ascending cervical branch (Figs. 81-84).

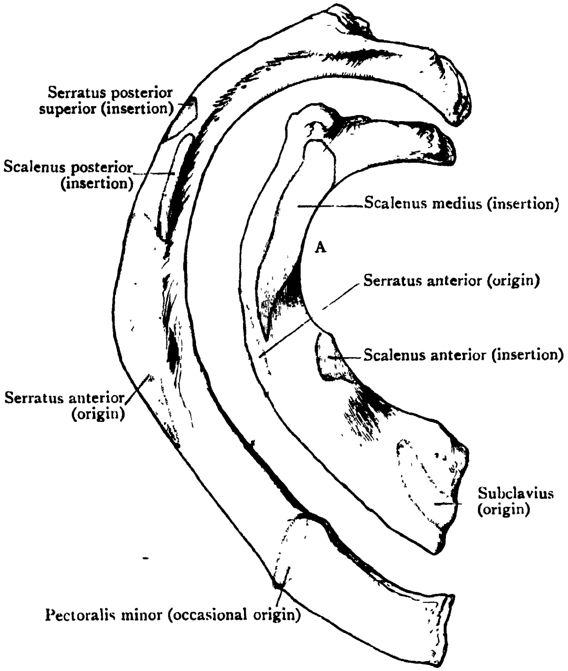

Serratus posterior superior (insertion)
Scalenus posterior (insertion)
Scalenus medius (insertion)
A
Serratus anterior (origin)
Scalenus anterior (insertion)
Serratus anterior (origin)
Subclavius (origin)
Pectoralis minor (occasional origin)

FIG. 92.—Muscle-Attachments to Upper Surface of First Rib and Outer Surface of Second Rib.

A, First rib; B, Second rib.

Scalenus Medius.—The scalenus medius is much larger and more powerful than the scalenus anterior. It springs from the posterior tubercles of all the cervical transverse processes (with the occasional exception of the first), and it is inserted into a rough, oval impression which marks the upper surface of the first rib between the tubercle of the rib and the groove for the subclavian artery (Fig. 92).

Relations.—It forms part of the floor of the posterior triangle of the neck. Its superficial surface is in relation with the brachial plexus and the third part of the subclavian artery. Its posterior border touches the levator scapulæ; and the nerve to the rhomboids and the deep branch of the transverse cervical artery pass between it and that muscle. The upper two roots of the nerve to the serratus anterior pierce the substance of the muscle; and the lower part of its anterior border is in relation with the apex of the pleura.

Scalenus Posterior.—This small muscle is generally inseparable, in its upper part, from the scalenus medius. It springs by two or three slips from the transverse processes of the lower cervical vertebræ, and is inserted into the upper border of the second rib, behind the large rough area which marks the origin of the serratus anterior (Fig. 92).

Structures Under Cover of the Sterno-Mastoid.—The deep dissection of the neck is now completed, and the dissectors should review the relative positions of the structures exposed—replacing the sterno-mastoid from time to time, and noting their relations to it also.

Muscles	Upper part of splenius capitis. Posterior part of posterior belly of digastric. Origins of longus capitis, levator scapulæ and scalenus medius. Rectus capitis lateralis. Scalenus anterior. Parts of the omo-hyoid, sterno-hyoid and sterno-thyroid.
Arteries	First and second parts of subclavian (separated by muscles). Thyro-cervical trunk and inferior thyroid (separated from sterno-mastoid by internal jugular vein). Suprascapular and transverse cervical. Common carotid (partly separated by muscles). Sterno-mastoid branch of superior thyroid. Lower parts of internal and external carotid. Occipital and its sterno-mastoid branch.
Veins	Internal jugular. Transverse part of anterior jugular. Occasionally, the lowest part of external jugular.
Nerves	Cervical plexus (separated by internal jugular vein). Branches of cervical plexus. Vagus (separated by internal jugular vein). Sympathetic trunk (separated by carotid arteries).
Other Structures	Numerous lymph-glands. Thoracic duct. Thyroid gland (separated by muscles). Cervical pleura (separated by various structures).

Cervical Fascia.—At various stages of the dissection, the deep fascia of the neck has been referred to, and parts of it have been described. The students are now at the stage when they can review the cervical fascia as a whole, and understand its connexions more fully.

In the dissection of the neck, students often suffer

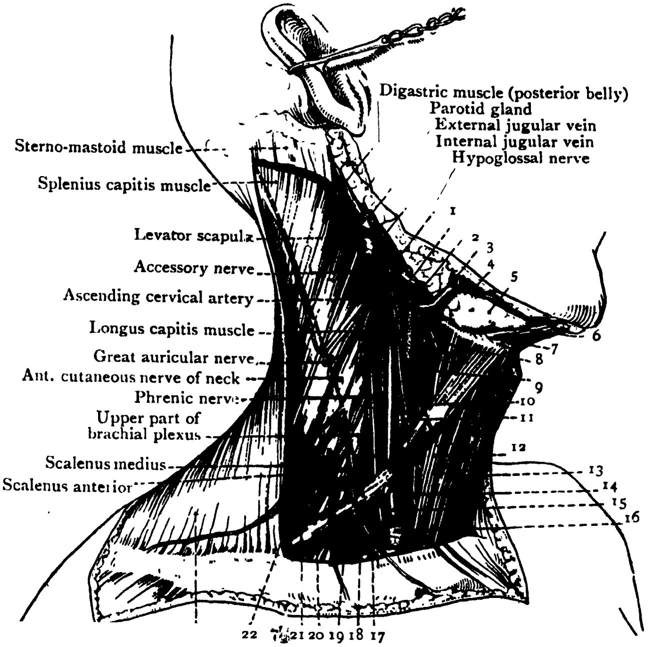


FIG. 93.—Dissection to show the structures under cover of Sterno-Mastoid. The outline of the Sterno-Mastoid is indicated by the thick black broken lines. The greater part of the Internal Jugular Vein has been removed to display the parts subjacent to it.

1. Internal carotid artery.
2. External carotid artery.
3. Anterior facial vein.
4. Submental vessels.
5. Submandibular gland.
6. Anterior belly of digastric muscle.
7. Mylo-hyoid muscle.
8. Superior laryngeal artery and internal laryngeal nerve.
9. Superior thyroid artery.
10. Upper end of thyroid gland.
11. Ansa hypoglossi.
12. Sterno-thyroid muscle.
13. Sterno-hyoid muscle.
14. Common carotid artery.
15. Vagus nerve.
16. Internal jugular vein.
17. External jugular vein.
18. Subclavian vein below supra-scapular artery.
19. Subclavian artery.
20. Omo-hyoid muscle (inferior belly).
21. Nerve to serratus anterior.
22. First serration of serratus anterior muscle.
23. Trapezius muscle.

disappointment in that they do not find the layers of fascia that are described. All fascial layers are due to stress or strain on the primitive areolar tissue in which the organs (muscles, glands, etc.) are originally embedded. The result of the stress or tension is the conversion of planes of areolar tissue into lamellæ of fibrous tissue which ensheath the muscles and other organs; but these lamellæ are so intermingled with fat that their demonstration in an ordinary dissection is difficult.

The portions of the cervical fascia to which different names have been given are the investing fascia, the prevertebral fascia, the pretracheal fascia, the bucco-pharyngeal fascia, the carotid sheath and the suprapleural membrane. Besides these, there are the fascia of the scalenus anterior, the sheet that covers the floor of the posterior triangle, the layer that envelops the infrahyoid muscles and the sheaths that invest the deep muscles in the back of the neck.

The **sheaths of the retro-vertebral muscles** require little more than mere passing mention. They separate the muscles of the back of the neck from one another; they are attached to the bones that give attachment to the muscles; small vessels run in them before entering the muscles; and so do the branches of the posterior primary rami of the cervical nerves.

The **prevertebral fascia** clothes the rectus capitis lateralis and the prevertebral muscles—longus cervicis, longus capitis and rectus capitis anterior. Superiorly, it is attached to the base of the skull. Inferiorly, it extends down over the longus cervicis to the third thoracic vertebra and fuses with the anterior longitudinal ligament and the periosteum of the vertebral bodies. Laterally, at the tips of the transverse processes, it is continuous with the fascia that covers the scalenus anterior and the fascia of the upper part of the floor of the posterior triangle.

The **fascia of the scalenus anterior** ensheaths the muscle; the part on its anterior surface is a very definite layer, and it is to be noted that the phrenic nerve lies between it and the muscle. At the lateral border of the muscle, the looser, areolar tissue on the front of this layer is prolonged, laterally and downwards, as a thin, indefinite layer over the subclavian artery and the brachial plexus, into the axilla.

The **fascia of the floor of the posterior triangle** covers the portions of the splenius capitis, levator scapulæ and scalenus medius that appear in the triangle. Medially, it is attached to the transverse processes, and its upper part is also continuous with the prevertebral fascia; postero-laterally, it is continuous with the sheaths of the deep muscles of the back of the neck. Superiorly it is attached to the superior nuchal line. Inferiorly, it follows the scalenus medius to the first rib, where it is continuous with the fascia of the serratus anterior. It therefore passes behind the brachial plexus; and its looser, more superficial part is prolonged into the axilla to form the posterior wall of the axillary sheath.

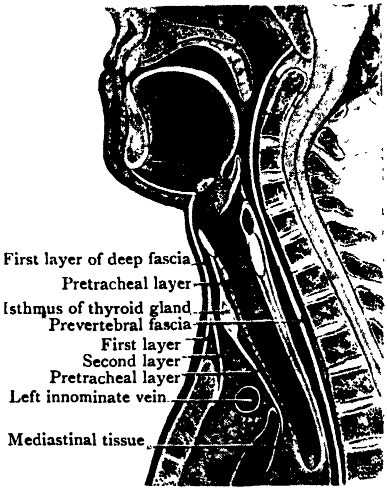


FIG. 94.—Diagram of Cervical Fascia in Sagittal Section.

The **investing fascia** ensheaths the neck as a whole; and, except at the upper part of the posterior triangle, it is a distinct layer with definite connexions.

Anteriorly, the fasciæ of the two sides are continuous at the median line, and they are adherent to the body and greater horns of the hyoid bone. As the fascia is traced backwards round the neck, it splits to enclose the sterno-mastoid, and again to cover both surfaces of the trapezius. The layers that enclose the trapezius are attached, in the median line, to the ligamentum nuchæ, while, inferiorly, they extend downwards into the back of the trunk.

In the lower part of the side and front of the neck, the two layers remain separate below a line drawn from the cricoid cartilage to the trapezius near the clavicle. The superficial layer is attached to the front of the upper part of the manubrium and to the upper surface of the clavicle. The second layer extends downwards to be attached to the back of the manubrium and to the lower border of the back of the clavicle, where it is continuous with the fascia on the back of the subclavius ; it is a distinct sheet where it clothes the deep surface of the sterno-mastoid, but beyond the borders of that muscle it is loose and indefinite, except where it fuses with the sheet that invests the infrahyoid muscles and borrows definiteness from it. The space between those two layers of the investing fascia is filled with loose, fatty tissue and certain other structures :—The part lateral to the sterno-mastoid contains a portion of the external jugular vein and the end of the transverse cervical vein ; and the supra-scapular vessels lie in that plane, between the clavicle and the second layer. The part between the right and left sterno-mastoids is called the *suprasternal space*; it contains the venous jugular arch and the interclavicular ligament.

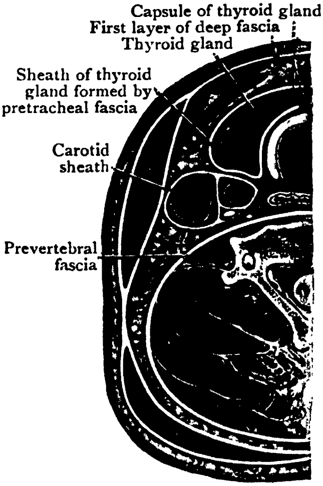

Capsule of thyroid gland
First layer of deep fascia
Thyroid gland
Sheath of thyroid gland formed by pretracheal fascia
Carotid sheath
Prevertebral fascia

FIG. 95.—Diagram of Cervical Fascia in Transverse Section at the level of the Thyroid Gland.

Superiorly, the investing fascia is attached to the superior nuchal line and the mastoid temporal bone. In front of that its chief attachment is to the lower border of the mandible ; but its connexions are complicated again by the splitting into two layers. In front of the mastoid temporal, its two layers ensheath the parotid gland. The layer prolonged upwards to cover the gland superficially is attached posteriorly to the external auditory meatus, superiorly to the zygoma and its roots, while, anteriorly, it fuses with the fascia on the masseter muscle. The deeper layer is very thin. It clothes both of the deep surfaces of the parotid gland—the postero-medial surface and the antero-medial. It is adherent to the posterior border of the mandible and to the styloid process, and is attached, superiorly, to the tympanic plate. The portion between the styloid process and the posterior border of the mandible gives attachment to some of the fibres of the stylo-glossus. As a result of the tension put upon it by that muscle, it is thicker than the rest of the deep portion of the sheath, and is given the name *stylo-mandibular ligament*; it separates the lower part of the parotid gland from the submandibular gland and the medial pterygoid muscle.

Lastly, as the fascia extends upwards from the hyoid bone, it splits into two layers, and part of it is strengthened and modified to form the pulley for the tendon of the digastric. The superficial layer, on its way to be fixed to the lower border of the mandible, covers the medial parts of the mylo-hyoid and digastric and the infero-lateral surface of the submandibular gland—forming the superficial layer of the sheath of the gland. The second layer extends upwards deep to the digastric and submandibular gland. It forms the deep layer of the sheath of the gland, and clothes the mylo-hyoid and the hyoglossus. Superiorly, it is attached to the mylo-hyoid line of the mandible; posteriorly, it becomes indefinite and joins the carotid sheath.

The **pretracheal fascia** covers the front and sides of the trachea, and splits to envelop the thyroid gland. On each side, the common carotid artery being in close relation with the trachea and the thyroid gland, the fascia blends with the carotid sheath. The portion in front of the trachea below the thyroid isthmus is loose and fatty, and contains the inferior thyroid veins; it extends downwards into the thorax to blend with the upper part of the back of the pericardium. The upward extent is determined by the thyroid gland; and it is attached, therefore, to the oblique line of the thyroid cartilage and to the first ring of the trachea or to the cricoid arch. On the superficial surface of the thyroid gland, it is fairly thick; but it is very ill-defined on the deep surface of both the isthmus and the lobe. Posteriorly, loose fibrous strands connect the fascia on the lobe with the fascia on the back of the œsophagus and with the prevertebral fascia.

The **fascia of the infrahyoid muscles** is sometimes well defined, especially in the angular interval between the sterno-thyroid and the inferior belly of the omo-hyoid. It clothes both surfaces of the muscles, and therefore separates their superficial stratum from the deeper. Medially, its deepest layer is indistinguishable from the pretracheal fascia and the carotid sheath; but, laterally, it can be lifted off the fascia of the scalenus anterior and the lateral extension of that fascia.

Its superficial layer may be fused with the second layer of the investing fascia, or the two may be quite distinct, especially on the deep surface of the sterno-mastoid. Traced upwards, it ends at the supero-lateral border of the omo-hyoid. Traced downwards, it is attached to the back of the manubrium, the first costal cartilage and the clavicle. The strong part between the sterno-thyroid and the inferior belly of the omo-hyoid, by its connexion with the clavicle, holds that belly down in place.

The **bucco-pharyngeal fascia** is a delicate layer of fibrous tissue that clothes the constrictor muscles on the back and the sides of the pharynx, and extends forwards to cover the buccinator muscle also. It extends from the base of the skull to the lower end of the pharynx and is then continued onwards over the œsophagus. Posteriorly, it is connected with the prevertebral fascia by the loose areolar tissue of the retro-pharyngeal space, which is sometimes dense opposite the margins of the back of the pharynx. On the side, at the gap between the skull and the superior constrictor, it covers the levator and the tensor palati; at the gap between the superior and middle constrictors, where the pharyngeal wall is wholly fascial, it blends with the pharyngo-basilar fascia, which lines the inner surface of the constrictors; at the gap between the middle and inferior constrictors, it covers the stylo-pharyngeus, which appears in that interval as it approaches the posterior border of the thyroid cartilage.

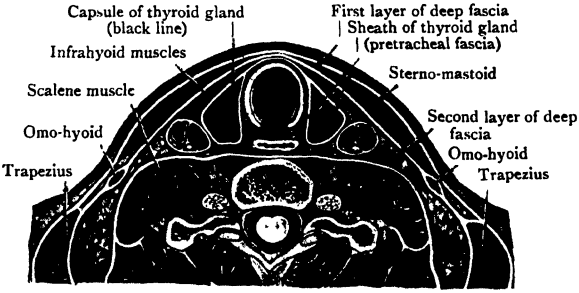

Capsule of thyroid gland (black line)
Infrahyoid muscles
Scalene muscle
Omo-hyoid
Trapezius
First layer of deep fascia
Sheath of thyroid gland (pretracheal fascia)
Sterno-mastoid
Second layer of deep fascia
Omo-hyoid
Trapezius

FIG. 96.—Diagram of Cervical Fascia in Transverse Section of lower part of neck.

The **carotid sheath** is the fascia arranged around the common and internal carotid arteries, the internal jugular vein and the vagus nerve; it extends, therefore, from the base of the skull to the root of the neck. It is connected with the fasciæ of the structures that surround the vessels. Thus, posteriorly, the vessels are in close relation to the prevertebral and scalene muscles, and it is connected with their fasciæ; medially, the carotid arteries are related to the trachea, thyroid gland and pharynx, and the sheath is connected with the pretracheal and bucco-pharyngeal fasciæ. Antero-laterally, the connexion, in the uppermost part, is with the fascia deep to the parotid gland and the posterior belly of the digastric, in the middle part, with the fascia of the sterno-mastoid, and, in the lower part, with the fascia of the infrahyoid muscles. The sheath may be blended with parts of those surrounding fasciæ, and is connected with other parts of them by loose areolar tissue—the intimacy of the connexion varying in different bodies as well as in different parts of the sheath.

The **suprapleural membrane** is a fascial sheet that springs from the seventh cervical transverse process and spreads over the cervical pleura to be attached to the inner border of the first rib. It separates the pleura from the overlying structures in the root of the neck. Infero-medially, it has no definite margin, but merges into the loose tissue between the pleura and the innominate vein. In some bodies, it springs from the transverse process by a fleshy slip (*scalenus pleuralis*), and has radiating tendinous fibres in its superficial part.

Lymph-Glands and Lymph-Vessels of Head and Neck.—The dissectors have doubtless encountered some of the lymph-glands, especially along the carotid sheath and in the root of the neck; but, as in other parts of the body, the situations of the glands and the course of the lymph-vessels cannot be demonstrated satisfactorily except by special methods of injection. The dissectors should, however, make a brief study of the general arrangement of the glands, and note the areas that are drained by the several groups.

The lymph-glands of the head and neck are very numerous. As a whole, they fall into two main sets. One set is made up of five pairs of separate groups, situated at or near the junction of the head with the neck and forming a "peri-cervical circle" (Poirier and Cunéo). The other set consists of chains of glands that descend from the "circle" towards the root of the neck, and are associated with the three pairs of jugular veins and with the larynx and trachea.

The five pairs of groups in the " circle " drain the lymph from all the superficial parts of the head and some of the deeper parts; and they are assisted in the drainage of the deeper parts by a sixth pair of groups situated behind the pharynx. The efferent vessels of all these groups pass to the cervical chains of glands, which receive, in addition, lymph-vessels directly from the tongue and structures in the neck.

The groups in the peri-cervical circle are named from their positions—occipital, mastoid, parotid, submandibular and submental; and those behind the pharynx are called retropharyngeal.

The *occipital lymph-glands* are a few small glands that lie on the upper end of the trapezius and on the fascia at the apex of the posterior triangle. They drain the occipital part of the scalp and the upper part of the back of the neck. Their efferent vessels pass under the posterior border of the sterno-mastoid to reach the glands under cover of the muscle.

The *mastoid lymph-glands* are a similar group that lie on the upper end of the sterno-mastoid. They drain the posterior half of the side of the head and the back of the auricle. Their efferents pass through the sterno-mastoid, or sweep round its anterior border, to reach the deep glands.

The *parotid lymph-glands* are numerous small glands intimately related to the parotid salivary gland—some embedded in its lateral surface and some in its substance, while a few are deep to it. They drain a great part of the head—the superficial members drawing lymph from the superficial parts and the deep members from the deep parts. Their territory includes the anterior half of the scalp, the front of the face down to the root of the nose, the upper half of the side of the face, the upper molar teeth and gums, the temporal and infratemporal regions, the auricle, the external auditory meatus, the tympanum and pharyngo-tympanic tube, the lacrimal gland and the parotid gland itself. The various members of the group are connected by lymph-vessels, and the final efferents emerge from those that lie between the lower part of the parotid salivary gland and the sterno-mastoid; some of these efferents end in the glands on the surface of the sterno-mastoid alongside the external jugular vein; the others pass to the deep glands.

The *submandibular lymph-glands*—three to six in number —lie in a row, under cover of the deep fascia, in the groove between the mandible and the submandibular salivary gland, both behind and in front of the facial vessels. Like the parotid group, they receive lymph from both superficial and deep parts—from the lower part of the side of the face, from the front of the face below the root of the nose (except the median part of lower lip and chin), from the submandibular and sublingual salivary glands, from the floor of the mouth, the anterior part of the tongue (except the tip) (Fig. 134), most of the teeth and gums, part of the palate and the anterior part of the walls of the nasal cavity. Their efferents pass to the deep glands under cover of the sterno-mastoid. Associated with the submandibular group, there are a few small, outlying, inconstant glands. These are called the *facial glands*, and when present they interrupt the lymph-vessels that accompany the anterior facial vein. The most constant of them is a single *mandibular gland* that lies on the mandible immediately in front of the masseter; it interrupts some of the vessels from the lower lip, and may be infected in cancer of the lip.

The *submental lymph-glands* are three or four small glands that lie between the anterior bellies of the digastric muscles, on the deep fascia that clothes the lower surface of the mylo-hyoid muscle. They receive the lymph from the median part of the chin and lower lip, the tip of the tongue (Fig. 134), the lower incisor teeth and gums, and the anterior part of the floor of the mouth. Their efferents pass to the deep glands under the sterno-mastoid. Though the submental glands are small, they are among the few lymph-glands that can be felt in the living person even when they are healthy.

The *retro-pharyngeal lymph-glands* are embedded in the fascia on the back of the upper part of the pharynx, at the level of the hollow below the auricle. There may be one or two tiny glands near the median plane, but the larger glands are situated more laterally, and are seldom more than two in number on each side. They receive lymph from the oral and nasal parts of the pharynx, the palate, the nose and air-sinuses, the pharyngo-tympanic tube and the middle ear. Their efferents pass to the deep cervical glands.

The *cervical chains* of glands are placed in three classes—superficial, anterior, and deep.

The *superficial cervical lymph-glands* are associated with the external and anterior jugular veins. Those alongside the external jugular vein are three or four in number and are really outlying members of the parotid group; they lie therefore immediately below the parotid salivary gland, but one of them may be lower. They receive the lymph-vessels from adjoining skin and from the parotid lymph-glands. Their efferents curve round the anterior border of the sterno-mastoid to end in deep glands in the carotid triangle; but, occasionally, one of them follows the external jugular vein to a deep gland in the root of the neck. One or two small glands lie on the anterior jugular vein. They receive lymph from the skin and muscles of the front of the neck and transmit it to the deep glands—the main efferent following the anterior jugular vein to its termination.

The *anterior cervical lymph-glands* are fairly numerous small glands that drain lymph from the larynx, trachea and thyroid gland, and transmit it to the deep glands. One lies on the isthmus of the thyroid gland or on the crico-thyroid ligament. Two or three are embedded in the back of the lobe of the thyroid gland. Most of them lie on the front and sides of the trachea—especially along the recurrent laryngeal nerve—forming chains that are continuous with the tracheo-bronchial groups in the thorax.

Deep Cervical Lymph-Glands.—These are the largest, the most numerous and the most important of the lymph-glands in the head and neck. They form a broad, multiple chain that extends from the posterior belly of the digastric muscle to the root of the neck (Fig. 134). Most of them lie under cover of the sterno-mastoid muscle in close relation with the carotid sheath—especially alongside the internal jugular vein. There are, however, important outcrops into the posterior triangle:—(*a*) The cluster that surrounds the accessory nerve in the hollow below the auricle extends, as a chain of three or four glands, along the nerve across the posterior triangle. (*b*) At the root of the neck, a chain extends along the transverse cervical vessels into the posterior triangle and over the upper part of the brachial plexus.

The deep cervical glands are linked together by afferent and efferent vessels. They receive lymph-vessels directly from all parts of the neck and from parts of the head. They receive also the efferents from all the other groups. Thus, all the lymph of the head and neck passes through them. Their final efferent vessels unite in the root of the neck to form the *jugular lymph-trunk.* Usually the left trunk ends in the thoracic duct, the right trunk in the internal jugular vein. (See p. 221.)

The deep cervical glands are of great clinical importance, for they are often invaded by tuberculous disease or by malignant growths. In the early stages of their enlargement by disease, those on the lateral side of the internal jugular vein can be felt as nodular swellings along the posterior border of the sterno-mastoid muscle. In later stages, the side of the neck may be greatly swollen and distended with masses of enlarged glands. Enlargement of those that surround the accessory nerve below the root of the auricle may displace that nerve considerably. Treatment of tuberculous glands in the neck is now generally carried out by methods other than open operation. But, even yet, it may be necessary to remove as many as possible of the deep glands when they are infected by malignant disease carried to them by lymph-vessels from a cancerous tongue, for example. In such a case, the intimate relation of the glands to the internal jugular vein is of great importance, and it may be impossible to remove the mass of diseased glands without taking the vein away with them.

The next dissection is that of the prevertebral region. If the Thorax has been allotted and its dissection completed, remove the Head and Neck and the upper part of the thorax from the rest of the trunk by cutting through the joints between the third and fourth thoracic vertebræ. By disarticulation at that level the lower attachments of the scalene muscles and the longus cervicis are retained.

If the Thorax has not been dissected, make the division between the sixth and seventh cervical vertebræ. The only parts lost by the higher division are the thoracic parts of the longus cervicis muscles, for the scalene muscles have been examined already.

PREVERTEBRAL REGION

The following are the structures to be displayed in the prevertebral area :—

Prevertebral muscles.
Intertransverse muscles.
Cervical nerves.
Vertebral vessels.
Vertebral and cranio-vertebral joints.

Dissection.—To separate the anterior part of the head, with the pharynx, from the posterior part and the vertebral column, a complicated dissection is necessary.

Place the head upside down, so that the cut margin of the skull rests on the table. If the upper ribs have been retained, divide the common carotid artery, the internal jugular vein, the vagus nerve, and the sympathetic trunk, on each side, at the level of the neck of the first rib. Pull the trachea and œsophagus, together with the great blood-vessels and nerves, away from the vertebral column ; the separation must be effected right up to the base of the skull. At that point great caution must be observed ; otherwise, the pharyngeal wall or the insertions of the prevertebral muscles will be damaged. The base of the skull having been reached, carry the point of the knife across the basilar portion of the occipital bone (basi-occiput), between the pharynx and the prevertebral muscles to divide the periosteum, which is very thick.

Now, divide the basi-occiput with a chisel. Still retaining the part upside down, place the skull so that its floor rests upon the end of a wooden block. Apply the chisel to the basi-occiput, adjust it accurately between the pharyngeal wall and the prevertebral muscles, and with a wooden mallet drive it through the base of the skull, inclining it, at the same time, slightly backwards.

The next step consists in making a pair of saw-cuts through the cranial wall. Place the head on its side, apply the saw to the side of the skull half an inch behind the mastoid process, and carry it obliquely forwards and medially to a point immediately behind the jugular foramen. Make a similar saw-cut on the opposite side of the head.

To complete the dissection, use the chisel again. Place the specimen so that the floor of the cranial cavity looks upwards, and divide the base of the skull, on each side, in the interval between the petrous temporal bone and the basi-occiput. Anteriorly, this cut should reach the lateral extremity of the incision already made through the basi-occiput ; posteriorly, carry it to the medial side of the jugular foramen to reach the medial end of the corresponding saw-cut. Finally, separate the anterior part of the specimen from the posterior part.

The only large nerve that has been divided is the hypoglossal, but, as it is connected with the vagus, it retains its position.

Cover the anterior part of the specimen with a piece of cloth soaked in preservative solution, wrap it in a piece of oil-cloth, and lay it aside until the dissection of the posterior part has been completed.

Return to the posterior part, and define the attachments of the prevertebral muscles.

Prevertebral Muscles.—These are three pairs of muscles, named the longus cervicis, longus capitis and rectus capitis anterior, that lie on the front of the cervical and upper thoracic vertebræ. They are covered with the prevertebral fascia, are supplied by twigs from the anterior primary rami of the cervical nerves, and they bend the head and neck forwards.

The **longus cervicis** (longus colli) is the longest and most medial of the three. It extends from the anterior tubercle of the atlas to the lower part of the body of the third thoracic vertebræ, and, between those points, it is attached by slips to the vertebral bodies and the cervical transverse processes. See Fig. 97.

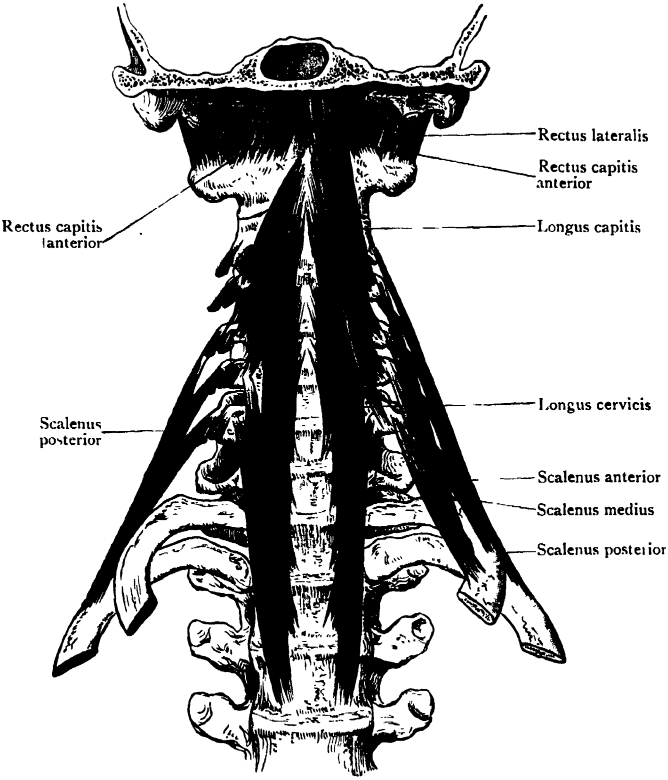


FIG. 97.—Prevertebral and Scalene Muscles and Rectus Lateralis (Paterson). On the right side, the longus capitis and scalenus anterior and medius have been removed.

The **rectus capitis anterior** is a short, wide muscle that arises from the front of the lateral mass of the atlas and is inserted into the base of the skull immediately in front of the occipital condyle.

The **longus capitis** lies between the other two muscles and overlaps both. Its origin is similar to that of the scalenus anterior—viz., by slips from the third, fourth, fifth and sixth cervical transverse processes. It is inserted into the base of the skull in front of the rectus anterior.

Dissection.—Re-examine the attachments of the scalene muscles. Then, remove them and the longus capitis from their origins, and clean the _intertransverse muscles_—taking care of the cervical nerves, for they are closely related to these muscles.

Intertransverse muscles.—These are small slips that connect transverse processes. In the neck there are two—an anterior and a posterior—between each two transverse processes; but the anterior one between the atlas and the axis is usually absent. The rectus capitis anterior and lateralis are modified intertransverse muscles. The anterior primary rami of the cervical nerves pass laterally between the anterior and posterior intertransverse muscles; and the posterior primary rami pass backwards across the medial side of the posterior muscles.

Dissection.—To expose the vertebral artery as it traverses the foramina in the cervical transverse processes:—Remove the intertransverse muscles and the muscles still attached to the transverse process of the atlas. With bone-forceps, snip off the anterior tubercles and the costal portions of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ.

Vertebral Artery.—The vertebral artery is a vessel of great importance, for, together with its fellow of the opposite side and the basilar artery, which is formed by their union, it supplies the hind-brain, the mid-brain, and the posterior part of the cerebrum, and it helps to supply the spinal cord.

It begins in the root of the neck as a branch of the first part of the subclavian artery, and it runs upwards through the transverse processes of the upper six cervical vertebræ to the base of the skull. It enters the skull through the foramen magnum, and unites with its fellow of the opposite side, at the lower border of the pons, to form the basilar artery (Fig. 169). On account of its varying relations it is divided into four parts.

The *first part* extends from the subclavian artery to the transverse process of the sixth cervical vertebra, and has been examined already (p. 216).

The *second part*, now exposed, begins where the artery enters the transverse process of the sixth cervical vertebra. It passes vertically upwards through the foramina transversaria till it reaches the foramen in the transverse process of the axis vertebra. From that foramen, it runs laterally, as well as upwards, to gain the foramen in the transverse process of the atlas—which is placed more laterally (Figs. 81, 82, 98).

As the artery emerges on the upper surface of the atlas (Figs. 20, 98), the *third part* begins and curves round the lateral side and the back of the upper articular process of the atlas, in a groove on the upper surface of its posterior arch, and passes under cover of the free, lateral part of the lower margin of the posterior atlanto-occipital membrane to become the fourth part.

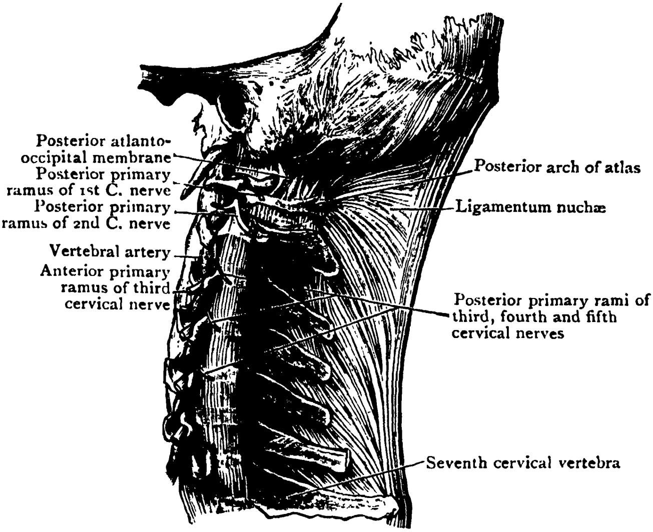

Posterior atlanto-occipital membrane
Posterior primary ramus of 1st C. nerve
Posterior primary ramus of 2nd C. nerve
Vertebral artery
Anterior primary ramus of third cervical nerve
Posterior arch of atlas
Ligamentum nuchæ
Posterior primary rami of third, fourth and fifth cervical nerves
Seventh cervical vertebra

FIG. 98.—Dissection of Ligamentum Nuchæ and Vertebral Artery in the Neck.

The *fourth part* turns upwards, pierces the dura mater, and enters the skull through the foramen magnum, in front of the uppermost tooth of the ligamentum denticulatum; then, turning antero-medially, between the hypoglossal nerve above and the first cervical nerve below, it passes to the anterior surface of the medulla oblongata, and, as already stated, joins its fellow of the opposite side at the lower border of the pons (Fig. 44).

Relations.—The relations of the *first part* have already been sufficiently considered (p. 216).

The *second part* lies in and between the transverse processes of the cervical vertebræ, medial to the intertransverse muscles, lateral to the bodies of the vertebræ, and in front of the anterior primary rami of the cervical nerves. It is surrounded by a sympathetic nerve-plexus which is derived from the inferior cervical ganglion and accompanies all parts of the artery, and also by a venous plexus which terminates, below, as the vertebral vein or veins.

The *third part* of the artery lies on the posterior arch of the atlas in the suboccipital triangle. As the artery turns backwards from the foramen in the transverse process of the atlas, it has the first cervical nerve and the lateral mass of the atlas on its medial side and the rectus capitis lateralis on its lateral side ; and, as it turns medially behind the upper articular process of the atlas, the trunk of the first cervical nerve lies below it, on the posterior arch of the atlas, and the posterior primary ramus enters the triangle from beneath its lower border.

For the relations of the *fourth part*, see pp. 123, 401.

Branches.—No branch of importance is given off from the first part. The second part gives off spinal (p. 88) and muscular branches. The branches from the third part are muscular twigs, and branches to anastomose with twigs from the occipital and the deep cervical arteries. The fourth part gives off a meningeal branch before it perforates the dura mater and, afterwards, a series of branches to the central nervous system (see p. 402).

Vertebral Vein.—Only the first part of the vertebral artery is accompanied by a definite vertebral vein. There are no accompanying veins with the fourth part of the artery, but a plexus is formed around the commencement of the third part by the union of tributaries from the networks of veins in the vertebral canal and in the suboccipital triangle. The plexus accompanies the second part of the artery through the transverse processes of the cervical vertebræ ; it anastomoses with the venous plexuses in the vertebral canal; and it terminates, below, as one or two *vertebral veins* which accompany the first part of the artery and cross the subclavian artery to end in the back of the innominate vein near its beginning.

Dissection.—Remove the muscles completely in order to examine the vertebral and cranio-vertebral joints and their ligaments. Define and clean the ligaments. Uncover the column of laminæ and spines that was laid aside when the vertebral canal was opened and clean the ligaments connected with it. If the cervical laminæ and spines were not removed, take away those below the axis vertebra by sawing through the laminæ at the medial sides of the articular processes.

JOINTS OF THE NECK

Typical Cervical Joints.—The *lower five* cervical vertebræ are united together very much on the same plan as the vertebræ in other regions of the vertebral column.

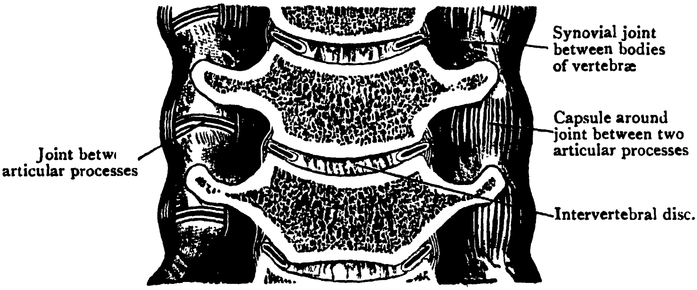

Synovial joint between bodies of vertebræ
Capsule around joint between two articular processes
Joint betw articular processes
Intervertebral disc.

FIG. 99.—Coronal Section through Joints between Bodies of Cervical Vertebræ.

The *bodies* of two contiguous vertebræ are united by an intervertebral disc and anterior and posterior longitudinal ligaments; the *articular processes* are united by a pair of capsular ligaments; the *laminæ* by a pair of ligamenta flava; the *spines* by interspinous and supraspinous ligaments; and the *transverse processes* by intertransverse ligaments. But certain additions and modifications will be noted in the following paragraphs.

Joints of Bodies of Vertebræ.—In the neck, there are three joints between the bodies of contiguous vertebræ—viz., the median cartilaginous joint and a pair of small synovial joints at the sides.

The *median joint* occupies by far the greatest part of the interval between the vertebral bodies, and it has the usual characters of a secondary cartilaginous joint: the opposed bony surfaces are coated with a thin layer of hyaline cartilage, and are connected together by a disc of fibro-cartilage. The intervertebral discs are distinctly deeper in front than behind, and upon that circumstance the cervical curvature of the column in great measure depends.

The *synovial joints* are placed one on each side of the disc (see Fig. 99). They are of small extent, and are confined entirely to the intervals between the more lateral parts of the bodies. The bony surfaces are coated with articular cartilage, and are separated by a synovial cavity enclosed by a feeble articular capsule.

The *anterior longitudinal ligament* is a long, strong, wide band placed on the anterior faces of the vertebral bodies, and firmly fixed to the discs and the margins of the bodies. In the upper part of the neck, it is reduced in width, and its upper end is attached to the tubercle on the anterior arch of the atlas.

The *posterior longitudinal ligament* lies on the backs of the vertebral bodies; it also is fixed to the discs and the margins of the bodies, and is long and wide—wider opposite the discs than the bodies, and therefore its edge is "toothed." It is widest in the cervical region, where it completely covers the bodies and does not present the denticulated appearance which is so characteristic lower down; and its upper end is attached to the back of the body of the axis.

Joints of Vertebral Arches.—The articular processes are united by *synovial joints.* The capsular ligament of each joint is attached around the margins of the articular surface, and, as movement is very free in the neck, it is more lax than in the lower regions of the vertebral column.

The *ligamenta flava* are flat bands of yellow elastic tissue that fill up the gaps between the laminæ, and can be seen best when the front of the specimen is viewed. Each is attached superiorly to the anterior surface and lower margin of the lamina above, whilst inferiorly it is fixed to the posterior surface and upper margin of the lamina next below. The laminæ and the ligaments, together, form a smooth, even posterior wall for the vertebral canal. Each ligament extends from the posterior part of the articular processes to the median plane, where its medial border is free and thickened and is separated from its fellow of the opposite side by a narrow, median slit. The slit is filled with some lax areolar tissue which allows the egress of some small veins from the vertebral canal. The width of the ligaments in the different regions of the vertebral column depends upon the size of the vertebral canal. They are widest therefore in the neck and in the lumbar part of the column. The ligamenta flava, by virtue of their great strength and elasticity, are powerful agents in maintaining the curvatures of the vertebral column; they also give valuable aid to the muscles in restoring the vertebral column to its original position after it has been bent forwards.

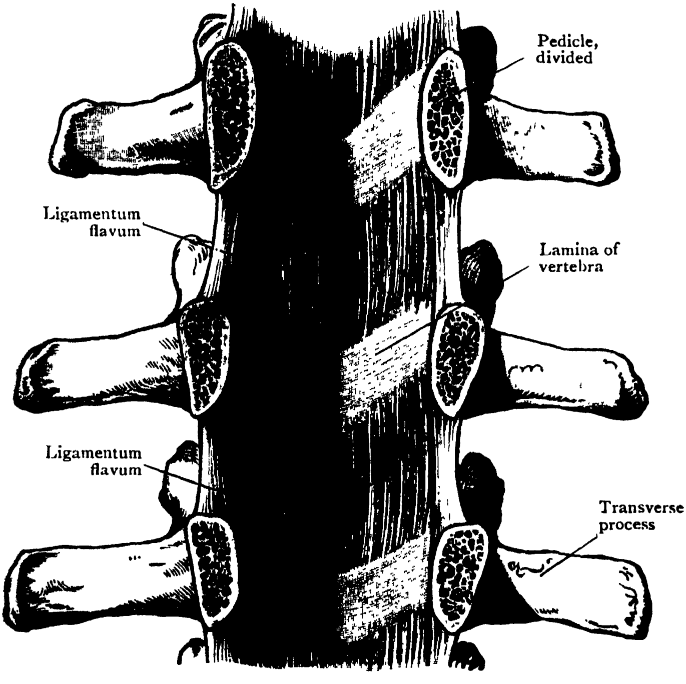


FIG. 100.—Ligamenta Flava in the Lumbar Region.

The *interspinous ligaments* fill the intervals between adjacent spines. They are most strongly developed in the lumbar region; in the thoracic region, and more so in the neck, they are very weak.

The *supraspinous ligaments* are thickened bands which connect the summits of the spine. In the neck they are replaced by the ligamentum nuchæ (p. 71).

The *intertransverse ligaments* are feebly marked in the cervical region and extend chiefly between the anterior bars of the transverse processes.

Joints of the Axis, Atlas, and Occipital Bone.—The uniting apparatus of these joints is very different from that of the joints of the lower five cervical vertebræ. They are all synovial joints. Between the atlas and axis there are three such joints—viz., a pair between the opposed articular processes, and a third between the odontoid process and the back of the anterior arch of the atlas. Between the atlas and occipital bone there is a pair of joints—viz., between the occipital condyles and the lateral masses of the atlas.

The axis is attached to the occipital bone by additional ligaments.

The ligaments connecting the three bones together may be divided into three main groups, as follows:—

Ligaments that connect atlas with axis	Anterior longitudinal ligament. Ligamenta flava. Capsular ligament. Lower part of cruciate ligament. Accessory ligaments of the atlanto-axial joints.
Ligaments that connect occipital bone with atlas . .	Anterior atlanto-occipital membrane. Posterior atlanto-occipital membrane. Upper part of cruciate ligament. Capsular ligament.
Ligaments that connect occipital bone with axis . .	Membrana tectoria. Longitudinal bands of cruciate ligament. Alar. Apical.

The uppermost part of the *anterior longitudinal ligament* passes from the front of the body of the axis to the tubercle on the anterior arch of the atlas.

A pair of *ligamenta flava* fills the interval between the laminæ of the axis and the posterior arch of the atlas. They are broader and more membranous than the ligamenta flava at lower levels.

The *capsular ligaments* are attached to the margins of the articular processes, and are rather lax.

The *anterior atlanto-occipital membrane* is a thin sheet that connects the upper border of the anterior arch of the atlas with the under surface of the occipital bone in front of the foramen magnum, and extends from one atlanto-occipital articular capsule to the other. In the median plane it is strengthened by a prolongation from the anterior longitudinal ligament (Fig. 101).

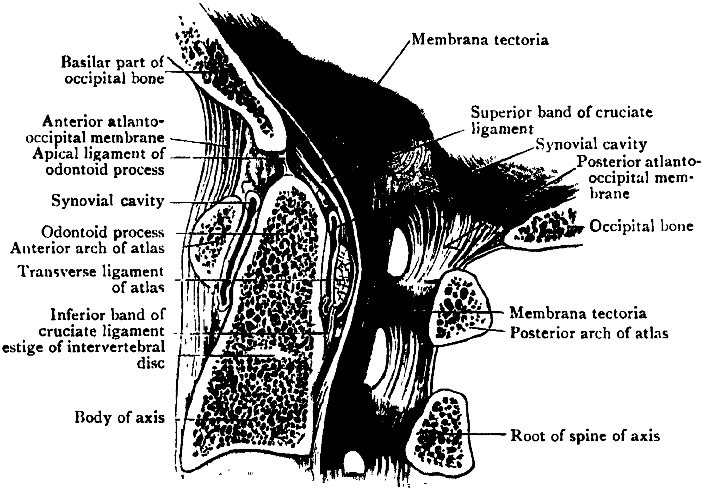

Basilar part of occipital bone
Anterior atlanto-occipital membrane
Apical ligament of odontoid process
Synovial cavity
Odontoid process
Anterior arch of atlas
Transverse ligament of atlas
Inferior band of cruciate ligament
estige of intervertebral disc
Body of axis
Membrana tectoria
Superior band of cruciate ligament
Synovial cavity
Posterior atlanto-occipital membrane
Occipital bone
Membrana tectoria
Posterior arch of atlas
Root of spine of axis

FIG. 101.—Median Section through the Atlanto-occipital and Atlanto-axial Joints.

The *posterior atlanto-occibital membrane* is thin and weak. It occupies the gap between the posterior arch of the atlas and the posterior border of the foramen magnum, to both of which it is attached. It is very firmly connected with the dura mater; and on each side it reaches the atlanto-occipital articular capsule. The lateral part of its lower border is not attached to the atlas but is a free and thickened edge that passes from the lateral mass of the atlas to the posterior arch, bridging over the groove which lodges the vertebral artery and the first cervical nerve. It is not uncommon to find this bridge ossified.

The *atlanto-occipital capsular ligaments* connect the occipital condyles with the lateral masses of the atlas. They completely surround the joints, and are connected in front and behind with the atlanto-occipital membranes.

The occipital bone around the foramen magnum is attached therefore by special ligaments to each of the four portions of the atlas—viz., to the anterior arch, to the two lateral masses, and to the posterior arch.

> ***Dissection.*—The remaining ligaments are placed within the vertebral canal, in relation to its anterior wall. To display them, remove the laminæ of the axis and the posterior arch of the atlas—using the bone-forceps. Remove also the squamous part of the occipital bone by sawing it through, on each side, immediately behind the jugular process and the condyle, carrying the saw cut into the foramen magnum. Then, carefully detach the upper part of the tube of spinal dura mater. A broad band—the *membrana tectoria*—is now exposed.**

The *membrana tectoria* is a broad ligamentous sheet which is attached, below, to the back of the body of the axis, where it is continuous with the posterior longitudinal ligament. It extends upwards, covering the odontoid process and the anterior margin of the foramen magnum, and is attached, above, to the upper surface of the occipital bone in front of the foramen magnum.

> ***Dissection.*—Detach the tectorial membrane from the axis and throw it upwards. The *accessory ligaments* of the atlanto-axial joints and the *cruciate ligament* are then in view, and very little further dissection is required to define them.**

The *accessory atlanto-axial ligaments* (Fig. 102) are a pair of strong bands which take origin from the back of the body of the axis close to the base of the odontoid process. Each band passes upwards and laterally, and is attached to the medial and posterior part of the corresponding lateral mass of the atlas. To a certain extent they assist the alar ligaments in limiting the rotary movements of the atlas on the axis.

The **cruciate ligament** has a cross-piece called the transverse ligament of the atlas and two longitudinal bands—an upper and a lower.

The *transverse ligament* is by far the most important constituent. It is a strong band which stretches from the tubercle on the medial side of one lateral mass of the atlas to the corresponding tubercle on the other. With the anterior arch of the atlas, it forms a ring which encloses the odontoid process —the pivot around which the atlas, bearing the head, turns. In the pivoting movements, it comes into contact with the sides of the odontoid process as well as the back of it; to lessen the friction, the surfaces are lubricated with synovia secreted by a loose membrane that usually completely shuts in the capillary interval between the ligament and the process, but this space may communicate with the joint between the odontoid process and the anterior arch of the atlas.

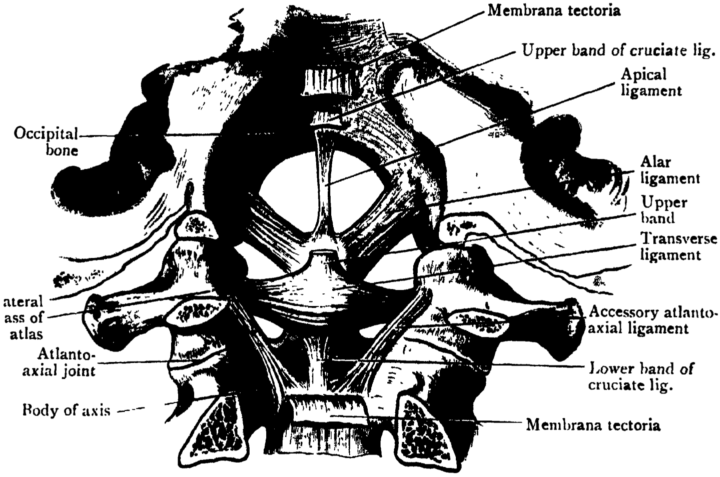


FIG. 102.—Dissection from behind showing the Ligaments that connect Occipital Bone, Atlas and Axis with one another.

The *longitudinal bands* are attached to the back of the transverse ligament. The *lower* band stretches down to the back of the body of the axis. The *upper* band is flatter and much longer. It stretches up to be attached to the upper surface of the occipital bone immediately in front of the foramen magnum.

> **Dissection.**—**Detach the upper longitudinal band from the occipital bone, and throw it downwards. The *apical ligament* is thus displayed, and a better view of the *alar ligaments* is obtained.**

The *apical ligament* of the odontoid process has two parts— an anterior and a posterior. The *posterior part* is a rounded cord-like ligament which stretches from the summit of the odontoid process to the anterior margin of the foramen magnum. Inasmuch as it is developed around a part of the notochord, it is a structure of considerable morphological interest. The *anterior part* of the apical ligament is a flat and weak band which is attached, above, to the same point as the posterior portion. Below, the two portions are separated by an interval filled with areolar tissue, and the anterior part is attached to the odontoid process immediately above its articular facet for the anterior arch of the atlas.

The *alar ligaments* (Fig. 102) are a pair of very powerful bands which spring from the sides of the summit of the odontoid process. Each passes sidewards and slightly upwards to be attached to the medial side of the occipital condyle. They limit rotation of the head, and in this they are aided by the accessory atlanto-axial ligaments.

Movements.—Nodding movements of the head are permitted at the atlanto-occipital joints. The rotatory movements of the head take place between the atlas and the axis ; and this pivoting movement of the atlas round the odontoid process is permitted by slight gliding at the atlanto-axial joints. Excessive rotation is checked by the alar ligaments.

MOUTH AND PHARYNX

The dissectors will now return to the anterior part of the skull, which was laid aside when the dissection of the pre-vertebral region was begun. The mouth and pharynx should engage their attention in the first instance.

Mouth.—The mouth is the first subdivision of the digestive system. Its cavity is controlled by muscles which are under the influence of the will, and it is separable into two parts : a smaller, external part, termed the *vestibule*, which separates the lips and cheeks from the teeth and gums ; and a larger part, called the *mouth proper*, which is enclosed by the teeth.

The mucous lining of the mouth should be thoroughly cleansed, and the two subdivisions of the cavity examined through the *oral fissure*.

Vestibule of the Mouth.—The vestibule is a mere cleft-like space, except when inflated with air. The parotid ducts and the ducts of the mucous glands of the lips and cheeks open into it. *Above* and *below*, it is bounded by the reflexion of the mucous membrane from the lips and cheeks on to the maxillæ and mandible. *Anteriorly*, it opens on the face by means of the oral fissure ; whilst *posteriorly*, it communicates, on each side, with the cavity of the mouth proper through the interval between the last molar tooth and the ramus of the mandible. The existence of that communicating aperture is of importance in cases of spasmodic closure of the jaws, when all the teeth are in place, because through it liquids may be introduced into the mouth proper.

In paralysis of the facial muscles the lips and cheeks fall away from the teeth and gums, and food is apt to lodge in the vestibule.

The various parts which bound the vestibule may now be examined in turn.

Lips.—The structure of the lips has, in a great measure, been examined already in the dissection of the face. There are four layers in each lip: (1) Cutaneous; (2) muscular; (3) submucous; and (4) mucous. The *skin* and *mucous membrane* become continuous with each other at the free margin of the lip. The mucous membrane is reflected from the lip on to the jaw, and is raised in the median plane in the form of a fold termed the *frenulum*. The *muscular layer* constitutes the chief bulk of the lips. It is formed by the orbicularis oris and the various muscles which converge upon the oral fissure. The *submucous layer* consists of areolar tissue which binds the mucous membrane to the muscular layer; and it contains numerous mucous glands, called *labial glands*, whose ducts pierce the mucous membrane and open into the vestibule. In each lip there is an arterial arch formed by the labial branches of the facial artery.

The lymph-vessels of the lower lip join the submental and submandibular lymph-glands; those of the upper lip pass to the submandibular and superficial parotid glands.

Cheeks.—Six layers can be distinguished in the cheeks, four of which were examined in the dissection of the face. They are :—(1) *Skin* ; (2) a *fatty layer*, traversed by some of the facial muscles and by the facial artery and anterior facial vein ; (3) the *bucco-pharyngeal fascia* ; (4) the buccinator muscle ; (5) the *submucous areolar tissue*, in which lie numerous *buccal glands* similar in character to the labial glands ; (6) the *mucous membrane*. Four or five mucous glands of larger size, termed the *molar glands*, occupy a more superficial position. They lie external to the bucco-pharyngeal fascia close to the point where it is pierced by the parotid duct, and their ducts open into the vestibule of the mouth. The *buccal pad of fat* lies in the deepest part of the fatty layer. The *parotid duct* pierces the pad and the inner four layers of the cheek, and opens into the vestibule of the mouth opposite the second upper molar tooth.

Gums and Teeth.—The gums are composed of dense fibrous tissue covered with a smooth and vascular mucous membrane. They are attached to the alveolar margins of the jaws and closely embrace the necks of the teeth.

In the adult, there are sixteen teeth in each jaw. From the median plane backwards, on each side, there are two incisors, one canine, two premolars and three molars.

Cavity Proper of Mouth.—The mouth proper is bounded in front and at the sides by the gums and teeth; posteriorly, it communicates with the pharynx by means of the opening called the *oro-pharyngeal isthmus*. The *floor* is formed by the tongue and by the mucous membrane which connects the tongue with the inner surface of the mandible; the *roof* is vaulted, and is formed by the hard and soft palate. It is into the mouth proper that the submandibular ducts and the ducts of the sublingual glands open (pp. 198, 199).

Floor of the Mouth.—The mucous membrane is reflected from the inner side of the mandible to the side of the tongue; but in the anterior part of the mouth the tongue lies more or less free in the oral cavity, and there the mucous membrane stretches across the floor from one half of the mandible to the other. On each side, in front, the *sublingual fold*—produced by the upward bulging of the sublingual gland—can be distinguished. Further, if the tongue is pulled upwards, a median fold of mucous membrane will be seen to connect its under surface to the floor. It is the *frenulum linguæ*. At the side of the frenulum, the dissectors must look for the opening of the submandibular duct on the summit of the *sublingual papilla*. The papilla is close to the frenulum, on the anterior

FIG. 103.—The Maxillary Sinus and the Cavity of the Mouth have been laid open, and the relation of the Sinus to the Orbit (which has been partly dissected) is shown.

1. Cut conjunctiva.
2. Orbicularis oculi muscle.
3. Orbicularis oculi muscle.
4. Inferior oblique muscle of the eyeball.
5. Infra-orbital artery and N.
6. Opening from maxillary sinus to middle meatus of nose.
7. Med. wall of maxillary sinus.
8. Levator labii superioris muscle.
9. Levator anguli oris muscle.
10. Facial artery.
11. Superior labial branch of facial artery.
12. Inferior labial branch of facial artery.
13. Orbicularis oris muscle.
14. Tongue.
15. Mylo-hyoid muscle.
16. Mandible.
17. Submental branch of facial artery.

PLATE IX

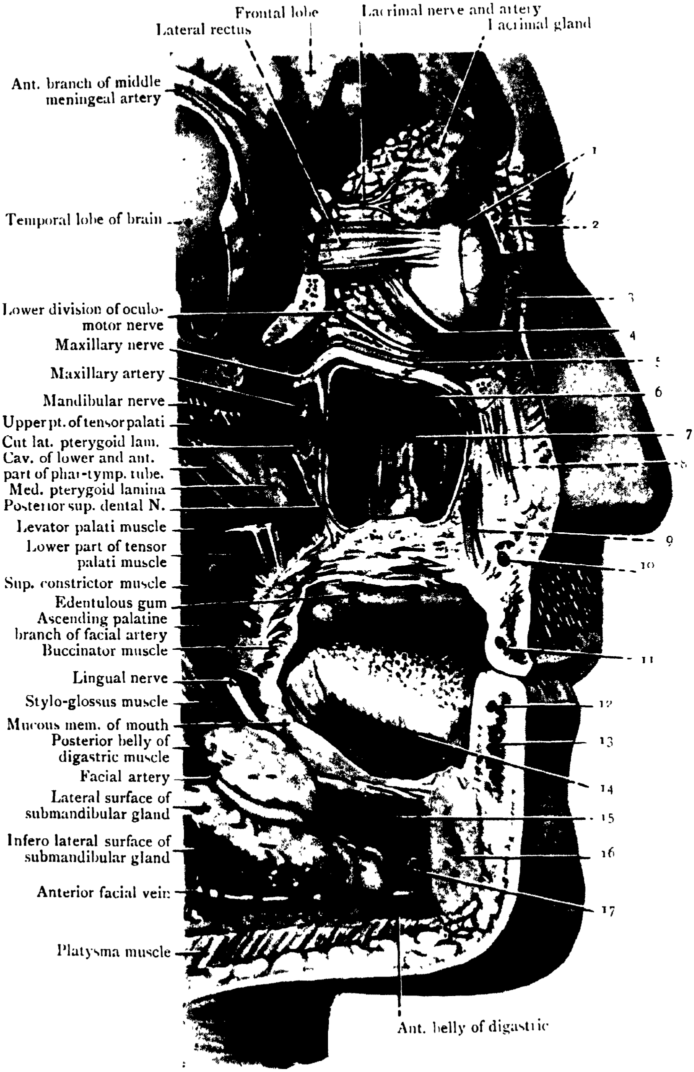


FIG. 103.—Deep Dissection of Face and Adjoining Parts. (Part of FIG. 54.)

PLATE X

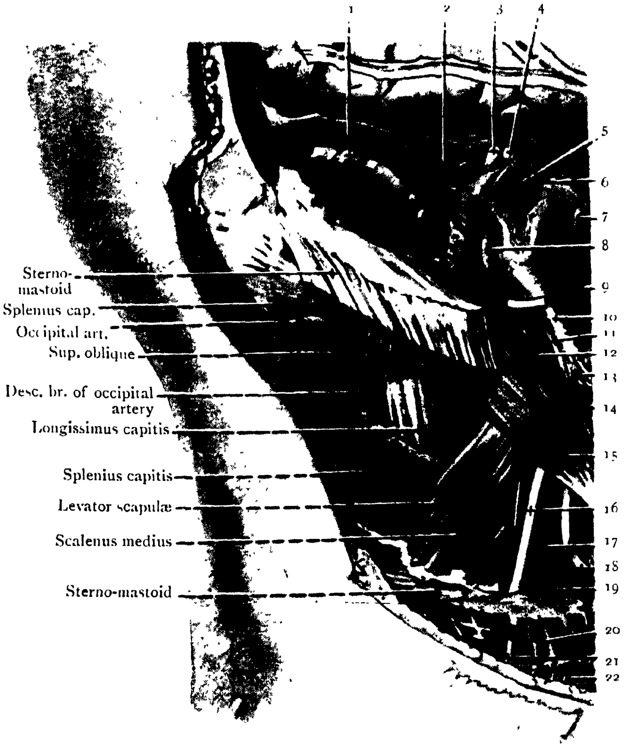


FIG. 104.—Part of the Dissection shown in Fig. 54.

1. Sigmoid sinus.
2. Tympanic antrum.
3. Incus.
4. Malleus.
5. Tympanic membrane.
6. Bony part of pharyngo-tympanic tube.
7. Spine of sphenoid bone.
8. Facial nerve.
9. Internal carotid artery.
10. Styloid process.
11. Stylo-hyoid muscle.
12. Internal jugular vein.
13. Stylo-glossus muscle.
14. External carotid artery.
15. Posterior belly of digastric muscle.
16. Accessory nerve.
17. Internal jugular vein.
18. Hypoglossal nerve.
19. Sterno-mastoid branch of occipital artery.
20. External jugular vein.
21. Great auricular nerve.
22. Platysma muscle.

end of the sublingual fold. The sublingual ducts open by minute apertures on the summit of the fold.

Roof of the Mouth.—The hard and soft palates form the continuous concave and vaulted roof of the mouth (Figs. 106, 108). The posterior margin of the soft palate is free; the *uvula* hangs down from its middle and rests on the dorsum of the tongue. A slight median ridge, called the *raphe*, runs forwards from the uvula, and ends anteriorly, below the incisive fossa, in a slight elevation termed the *incisive papilla*. In the anterior part of the hard palate the mucous membrane, on each side of the raphe, is thrown into three or four hard transverse corrugations or ridges; farther back, it is comparatively smooth. By carefully palpating the postero-lateral angle of the hard palate, the dissector will be able to feel the pterygoid hamulus, which can be felt also by the tongue in one's own head.

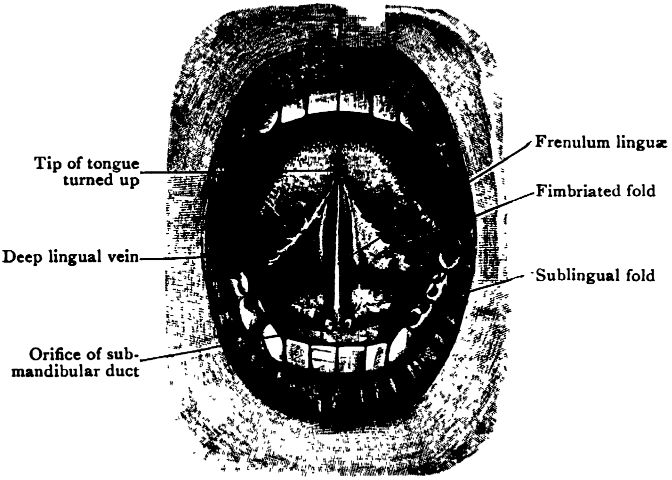


FIG. 105.—Sublingual Region and Lower Surface of Tongue.

Oro-Pharyngeal Isthmus (Isthmus Faucium).—This is the communication between the mouth proper and the pharynx (Fig. 106). To obtain a good view of it, open the mouth widely and depress the tongue. The isthmus and the parts which bound it can be examined best in the living body, and the dissectors should study their own oro-pharyngeal isthmus with the aid of a looking-glass. It is bounded above by the soft palate, below by the dorsum of the tongue, and on each side by a curved fold of mucous membrane termed the palato-glossal arch.

Each *palato-glossal arch* descends from the posterior part of the inferior surface of the soft palate and, inclining forwards as it descends, it ends on the side of the posterior part of the tongue. It encloses the palato-glossus muscle.

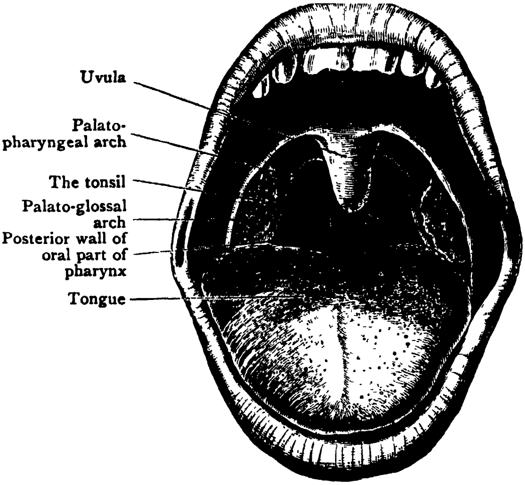


FIG. 106.—Oro-Pharyngeal Isthmus as seen through the widely-opened Mouth. The tonsils were slightly enlarged.

The palato-pharyngeal arch and the tonsil also can be seen; but they belong to the pharynx, with which they will be examined.

Pharynx.—The pharynx is a wide muscular tube lined with mucous membrane. It is about five inches long and extends from the base of the cranium to the level of the body of the sixth cervical vertebra (Fig. 108). There, behind the lower border of the cricoid cartilage, it becomes continuous with the œsophagus. It is behind the nasal cavities, the mouth and the larynx; and it is the passage which conducts air to and from the larynx and the food from the mouth to the œsophagus.

Under ordinary conditions it is expanded from side to side and compressed antero-posteriorly, so that it possesses anterior and posterior walls and two borders. Above the level of the inlet of the larynx there is always sufficient space for the passage of air to the lungs, but below that orifice the anterior and posterior walls are in contact except when separated by the passage of food (Figs. 108, 109, 110 A, 111).

It is widest above, at the base of the cranium, behind the orifices of the pharyngo-tympanic (auditory) tubes. Thence, it narrows to the level of the hyoid bone. It widens again at the level of the upper part of the larynx and then rapidly narrows to its termination.

To obtain a proper idea of the dimensions of the pharynx, distend it moderately by stuffing it with tow—introduced either from above, through the mouth, or from below, through the œsophagus.

Relations.—*Posteriorly*, the pharynx is bound to the prevertebral fascia by some lax areolar tissue which offers no impediment to its movements during deglutition. *On each side*, the pharynx is related to the great vessels and nerves of the neck, and to the styloid process and the muscles which take origin from it; and the pharyngeal plexus of nerves ramifies over it, and supplies it with motor and sensory twigs. *Anteriorly*, the pharyngeal wall is interrupted by the openings of the nasal cavities, mouth, and larynx; and it is from the structures which lie in proximity to those apertures that it derives its principal attachments.

Attachments.—*On each side*, from above downwards, it is attached:—(*a*) to the medial pterygoid lamina; (*b*) to the pterygo-mandibular ligament; (*c*) to the side of the tongue; (*d*) to the medial side of the mandible; (*e*) to the hyoid bone; (*f*) to the thyroid cartilage; (*g*) to the cricoid cartilage. *Above*, it is attached to the base of the skull. The various attachments will be studied more fully when the constituent parts of the walls are dissected.

Pharyngeal Wall.—There are five well-marked strata in the wall of the pharynx. From without inwards they are:—(1) bucco-pharyngeal fascia; (2) pharyngeal muscles; (3) pharyngo-basilar fascia; (4) submucous coat; (5) mucous membrane.

The *bucco-pharyngeal fascia* is a coating of fibrous tissue which covers both the buccinator and the pharyngeal muscles; the *pharyngo-basilar fascia* lines the deep surface of the pharyngeal muscles.

The muscular layer, which is composed of the three constrictor muscles, with the stylo-pharyngeus and palato-pharyngeus, must now be dissected.

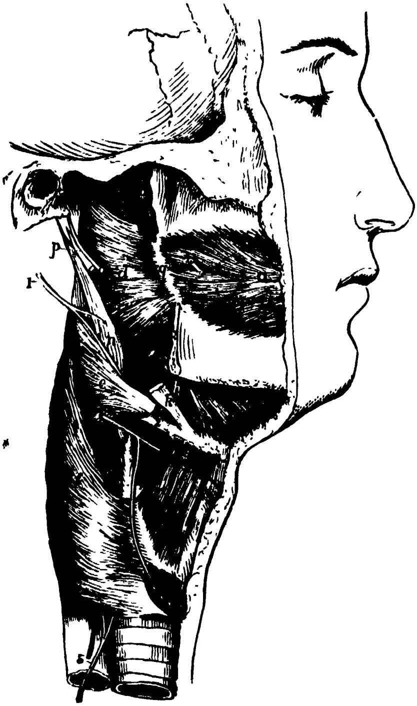
> ***Dissection.*—Remove the bucco-pharyngeal fascia and clean the pharyngeal muscles, sweeping the knife in the direction of their fibres. Note the plexuses of veins and nerves, and remove them.**

Pharyngeal Veins.—These veins lie between the muscles and the fascia on the posterior wall and the borders of the pharynx, where they anastomose together to form the *pharyngeal venous plexus*, which receives blood from the pharynx, soft palate, and prevertebral region. It communicates with the pterygoid plexus and the cavernous sinus. Two or more channels carry the blood from it to the internal jugular vein.

Constrictor Muscles.—The constrictor muscles are three pairs of curved sheets of muscular fibres that lie in the sides and posterior wall of the pharynx, and are so arranged that they overlap each other from below upwards (Fig. 107). They are inserted into the median fibrous *raphe* which descends in the posterior wall of the pharynx from the pharyngeal tubercle of the base of the skull. They are supplied by the pharyngeal plexus of nerves—the inferior constrictor receiving additional twigs from the external and recurrent laryngeal nerves.

The **inferior constrictor** muscle arises from the side of the cricoid cartilage and from the oblique line of the thyroid cartilage. The muscle curves backwards and medially to meet its fellow in the median raphe. The lower fibres are horizontal, but the remainder ascend, with increasing degrees of obliquity, until the highest fibres almost reach the base of the skull. The lower margin of the inferior constrictor overlaps the commencement of the œsophagus, and the recurrent laryngeal nerve and the inferior laryngeal artery pass upwards under cover of it to reach the larynx.

The **middle constrictor** is a fan-shaped muscle (Fig. 107, *e*). It arises from the greater and lesser cornua of the hyoid bone and from the lower part of the stylo-hyoid ligament. From those origins, its fibres pass round the pharyngeal wall to the median raphe. As they curve the lowest fibres descend, the highest ascend, and the middle fibres run horizontally. The lower portion of the muscle is overlapped by the inferior constrictor posteriorly; and in the interval which separates the margins of the muscles in the side of the pharynx, opposite the thyro-hyoid interval, the internal laryngeal nerve and the superior laryngeal artery will be seen piercing the thyro-hyoid membrane to gain the interior of the pharynx.



a. Buccinator.
b. Tensor palati.
c. Levator palati.
d. Superior constrictor.
e. Middle constrictor.
f. Inferior constrictor.
g. Thyro-hyoid.
h. Hyo-glossus.
k. Stylo-hyoid.
l. Mylo-hyoid.
m. Crico-thyroid.
n. Stylo-pharyngeus.
o. Stylo-glossus.
p. Stylo-hyoid ligament.
q. Pterygo-mandibular lig.
1. Glosso-pharyngeal nerve.
2. Superior laryngeal artery.
3. Superior laryngeal nerve.
4. External laryngeal nerve.
5. Recurrent laryngeal nerve and inferior laryngeal artery.

FIG. 107.—Profile View of Pharynx to show Constrictor Muscles. (Turner)

***Dissection.*—To bring the origin of the superior constrictor fully into view cut through the remains of the medial pterygoid muscle about its middle, and turn the two parts aside.**

The **superior constrictor** has a weak but continuous line of origin from the following parts:—(*a*) the pterygoid hamulus; (*b*) the pterygo-mandibular ligament; (*c*) the posterior end of the mylo-hyoid line of the mandible; (*d*) the mucous membrane of the mouth and side of the tongue. From their origins, the fibres curve backwards and medially to reach the median raphe; as a rule, some of the highest gain a distinct insertion into the pharyngeal tubercle.

The lower part of the superior constrictor is overlapped by the middle constrictor; and the stylo-pharyngeus passes into the interval between the two as it descends to its insertion (Fig. 107, *n*). The upper border of the muscle, which is free and crescentic, falls short of the base of the skull. This semilunar deficiency is compensated for by increased strength of the pharyngo-basilar fascia. On the outer surface of this part of the fascia, there are the upper parts of two muscles—the tensor palati anteriorly and the levator palati postero-medially—and, close to the base of the skull, the pharyngo-tympanic tube lies between the two muscles.

The *pterygo-mandibular ligament* (Fig. 107, *q*) is a strong, narrow, tendinous band which extends from the pterygoid hamulus to the posterior part of the mylo-hyoid line. It acts as a tendinous bond of union between the buccinator and superior constrictor muscles. Its connexions can be appreciated best by the finger introduced into the mouth and pressed laterally along the course of the ligament.

The *pharyngo-basilar fascia* is strong in its upper part and maintains the integrity of the wall of the pharynx where the superior constrictor is absent. As it passes downwards it gradually becomes weaker, until it is ultimately lost as a distinct layer. It lies between the muscles and the submucous coat and is visible, from the outside of the pharynx, only where the muscles are absent. It is the principal means by which the pharynx is attached to the base of the skull, and it is united also to the pharyngo-tympanic tubes and the bony margins of the posterior apertures of the nose.

***Dissection.*—Open the pharynx by a median incision through the entire length of its posterior wall, and a cross cut close to the base of the skull. Remove the stuffing and clean the mucous membrane.**

INTERIOR OF THE PHARYNX.—The *mucous membrane* lines the whole interior, and is continuous with the mucous membrane of the cavities that open into the pharynx or out of it—see next page.

The *submucous coat* contains great numbers of mucous *pharyngeal glands*. There are also numerous *lymph-nodules*, and in certain localities they are aggregated together into large masses called *the* tonsils and the naso-pharyngeal tonsil.

The soft palate extends into the pharynx and divides its cavity into an upper and a lower part. The *upper part*, called the *naso-pharynx*, communicates with the nasal cavities by the posterior apertures of the nose, and with the tympanic cavities by the pharyngo-tympanic tubes.

The *lower portion* of the pharynx is divisible into (1) an *oral part* placed behind the tongue and behind the mouth, which opens into it ; and (2) a *laryngeal part*, which is behind the larynx, and opens into the larynx and the œsophagus.

Nasal Part of Pharynx.—The naso-pharynx is situated immediately behind the nasal cavities and below the body of the sphenoid and the basilar part of the occipital bone. It is the widest part of the pharynx. Its walls, except the soft palate, are not capable of movement, and, consequently, its cavity always remains patent, and presents under all conditions very much the same form.

Its *anterior boundary* is occupied by the *posterior apertures of the nose*, through which it opens into the nasal cavities. These apertures are a pair of oblong orifices which slope from the base of the skull downwards and forwards to the posterior border of the hard palate. Each is about one inch long and half an inch wide, and it is separated from its fellow by the posterior part of the septum nasi. By looking through them, the dissector will obtain a partial view of the lower two meatuses of the nose and of the posterior ends of the middle and inferior conchæ.

On each *side wall* of the naso-pharynx, the orifice of the pharyngo-tympanic tube is seen, and, behind it, the pharyngeal recess. The *pharyngeal orifice* of the tube is at the level of the posterior end of the inferior concha of the same side. It is bounded above and behind by a prominent and rounded margin termed the *tubal elevation.* A fold of mucous membrane, termed the *salpingo-pharyngeal fold*, descends from the posterior lip of the orifice. The fold contains a slip of muscle called the *salpingo-pharyngeus*, and as it is traced downwards it gradually disappears.

The dissector should pass a Eustachian catheter through the nose into the tube. Hold the catheter with the point downwards. Pass it backwards through the right nasal cavity, along the septum of the nose, to the posterior wall of the pharynx. Pull it towards the palate till the bent end of the catheter catches against the back of the hard palate. Turn the point through a quarter of a circle to the right side and it will enter the right tube. To catheterise the left tube, pass the catheter through the left nasal cavity, and in the final stage turn the point to the left side.

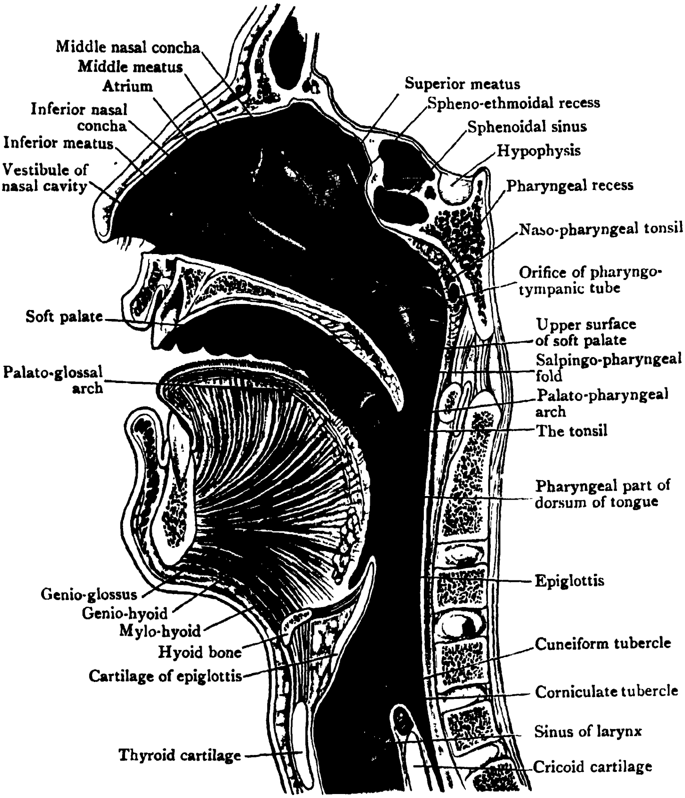


FIG. 108.—Sagittal Section through Nose, Mouth, Pharynx, and Larynx, a little to the right of the median plane.

In the natural condition of parts there is a deep recess on the side wall of the naso-pharynx immediately behind the posterior lip of the orifice of the tube. It is termed the *pharyngeal recess*.

PLATE XI

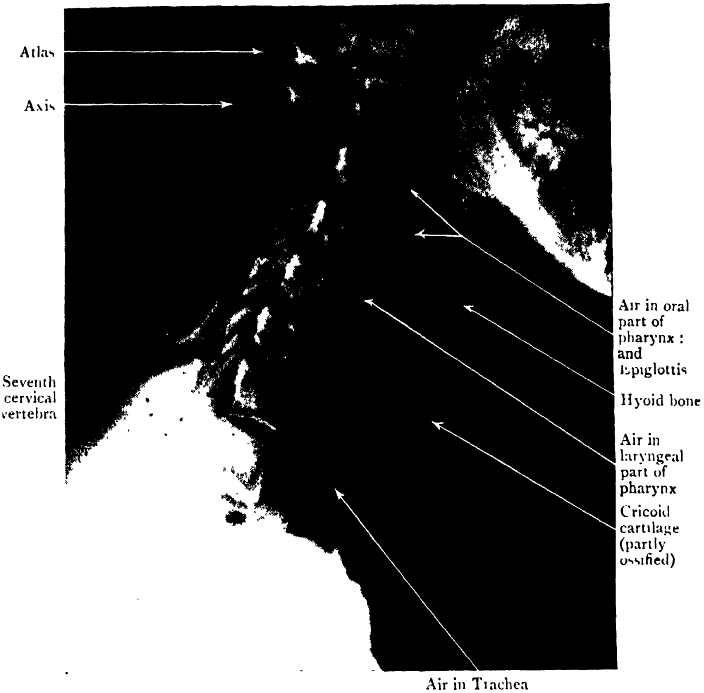

Atlas
Axis
Seventh cervical vertebra
Air in oral part of pharynx : and Epiglottis
Hyoid bone
Air in laryngeal part of pharynx
Cricoid cartilage (partly ossified)
Air in Trachea

FIG. 109.—Lateral Radiograph of Neck of man aged 36.

(Dr. J. F. Brailsford)

The positions of the Pharynx and the Trachea are shown, like air-sinuses of the head, by the relative translucency to the X-rays of their air-filled cavities. Note the closure of the post-cricoid portion of the laryngeal part of the pharynx.

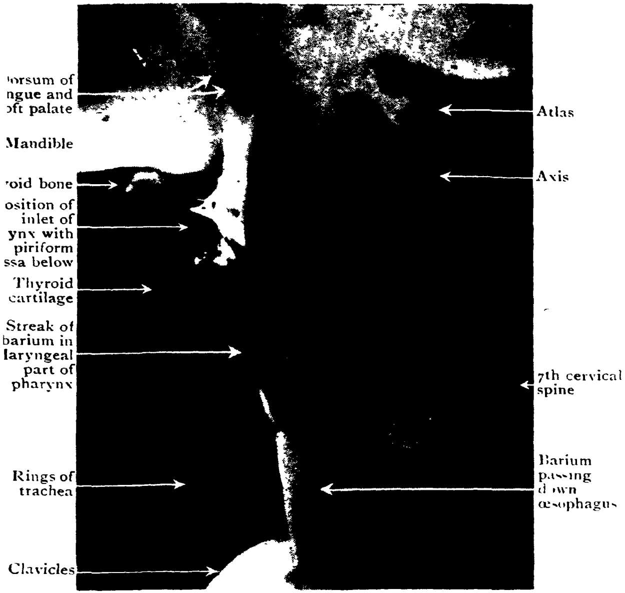


FIG. 110 A.—Lateral Radiograph of Neck of young woman, taken as "barium paste" is swallowed (Dr. R. McWhirter). Some barium remains in the oral pharynx and upper part of laryngeal pharynx.

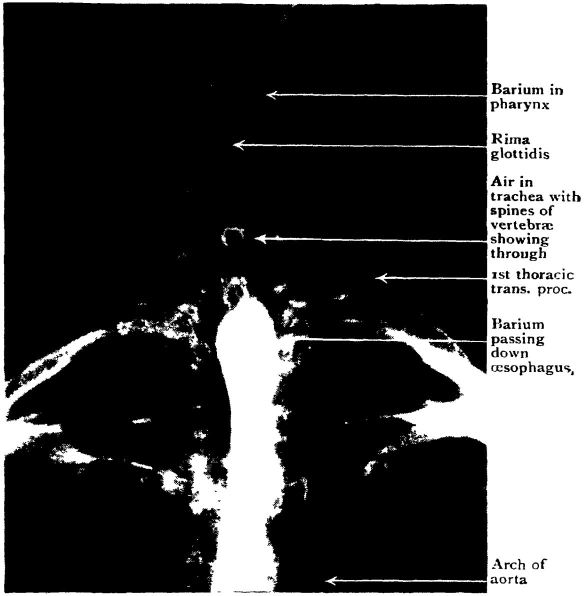


FIG. 110 B.—Antero-posterior Radiograph of Neck and upper part of Thorax of young woman as "barium paste" is swallowed (Dr. R. McWhirter). Note the deviation of the œsophagus to the left

The *roof* and *posterior wall* of the naso-pharynx are not marked off from each other, but form together a continuous curved surface. In the part of the roof which lies between the two pharyngeal recesses there is a marked collection of lymphoid tissue called the *naso-pharyngeal tonsil.* Over its surface the mucous membrane is thickened and wrinkled, and in its lower part a small median pit, termed the *pharyngeal bursa,* may sometimes be found; the bursa is only large enough to admit the point of a fine probe.

The *floor* of the naso-pharynx is the soft palate, and is curved and sloping. Between the posterior border of the soft palate and the posterior wall of the pharynx there is an oblique interval, termed the *pharyngeal isthmus,* through which the naso-pharynx communicates with the oral part of the pharynx.

The side boundary of the pharyngeal isthmus is a prominent fold of mucous membrane called the *palato-pharyngeal arch.* The arch can be distinctly seen in the living person—*e.g.*, in one's own mouth in a mirror. It begins at the posterior edge of the soft palate and sweeps downwards and backwards on the side wall of the pharynx, and gradually fades away. It encloses a slip of muscle called the *palato-pharyngeus.* When the right and left palato-pharyngeus muscles contract, they approximate the palato-pharyngeal arches; that, combined with the tightening and elevation of the soft palate by the tensor and levator palati and with the constriction of the pharynx by the superior constrictor, closes the pharyngeal isthmus; the passage of solid and liquid food into the naso-pharynx is thus prevented.

It is important to note that the posterior wall and roof of the naso-pharynx can be explored by the finger introduced through the mouth and the pharyngeal isthmus.

When the naso-pharynx is illuminated by light reflected from a mirror introduced through the mouth, a view of the four orifices which open into the nasal part of the pharynx may be obtained. Owing to the mirror being placed obliquely, and below the level of the hard palate, only the posterior parts of the inferior conchæ are visible, and the inferior meatuses of the nose are altogether out of sight. The middle and superior meatuses of the nose and the middle and superior conchæ, however, can be brought into view and their condition ascertained. The side walls of the naso-pharynx and the orifices of the pharyngo-tympanic tubes also can be fully inspected.

Oral Part of Pharynx.—The oral pharynx lies behind the mouth and tongue. The *anterior wall* of its lower part is therefore the pharyngeal part of the dorsum of the tongue, which looks more or less directly backwards.

Immediately behind the tongue there is the epiglottis, which belongs to the laryngeal part of the pharynx; but certain parts connected with it belong to the oral pharynx and should be examined now.

The *epiglottis* is a leaf-like plate of cartilage, largely enveloped in mucous membrane, and its upper part stands up prominently behind the tongue. Pull this part backwards and note the glosso-epiglottic and pharyngo-epiglottic folds and the epiglottic valleculæ.

The *glosso-epiglottic fold* is a median ridge of mucous membrane between the front of the epiglottis and the back of the tongue; the *epiglottic vallecula* is the depression on each side of it. The *pharyngo-epiglottic fold* is the ridge of mucous membrane that bounds the vallecula laterally; it extends from the margin of the epiglottis to the side wall of the pharynx at its junction with the tongue.

Above the tongue, there is the oro-pharyngeal isthmus, by which the pharynx communicates with the mouth.

The *posterior wall* has no outstanding feature.

The *side wall* is the interval between the palato-glossal and palato-pharyngeal arches; and it is occupied by the tonsil.

The **Tonsils** (Tonsillæ Palatinæ).—These are a pair of masses of lymphoid tissue of variable size. Each is placed in the side wall of the oral pharynx opposite a point a little above the angle of the mandible. It lies between the palato-glossal and palato-pharyngeal arches, above the back part of the tongue and below the soft palate. In early life, it is larger than the space enclosed by these boundaries, and burrows upwards into the soft palate and forwards under the palato-glossal arch.

Its *medial surface* is uneven and is covered with mucous membrane which dips into it to line deep, narrow crypts—about a dozen in number—called the *tonsillar pits*; the widest of these is in the upper part of the tonsil, and is called the *intratonsillar cleft*.

The *lateral surface* is related to the superior constrictor, which separates it from the facial artery at the point where that artery begins to bend downwards. The tonsil is, however, not in actual contact with the constrictor. Its lateral surface is covered with a thin fibrous sheet which, though it does not surround the whole tonsil, is called its *capsule;* and the capsule is connected by loose areolar tissue with the pharyngo-basilar fascia on the inner surface of the constrictor.

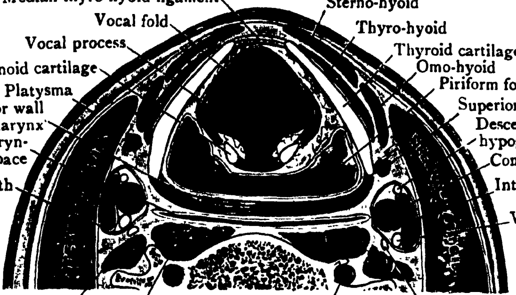


FIG. 111.—Transverse Section through the Neck at the level of upper part of Thyroid Cartilage.

Anteriorly, a fibrous band connects the capsule with the sheath of the palato-glossus, and helps to hold the tonsil in place during swallowing. One or more inconstant veins descend from the soft palate lateral to the capsule and pierce the superior constrictor. When these are represented by a single vein closely related to the capsule, it may be the source of the embarrassing bleeding that sometimes attends removal of the tonsil (Denis Browne).

Vessels and Nerves of Tonsil.—The chief **artery** of the tonsil is the tonsillar branch of the facial, which enters the lower part of its lateral surface. The **veins**—usually two—pierce the superior constrictor near the artery and either end in the pharyngeal plexus or unite to form a single stem which ends in the common facial. The **lymph-vessels** pierce the superior constrictor and pass partly laterally and partly downwards to the nearest glands—*i.e.* to those on the carotid sheath opposite the angle of the mandible, and to the posterior member of the submandibular group. The **nerves** are derived from the glosso-pharyngeal and the lesser palatine.

Laryngeal Part of Pharynx.—The laryngeal part of the pharynx is behind the larynx, and diminishes rapidly in width from above downwards.

Its *posterior wall* and *side walls* are covered with smooth mucous membrane, and present no peculiarities.

Its *anterior wall* is the back of the larynx, and the parts to be noted are :—(1) the inlet of the larynx and its boundaries; (2) a piriform fossa on each side of the inlet; and (3) the mucous membrane on the back of the arytenoid and cricoid cartilages below the inlet.

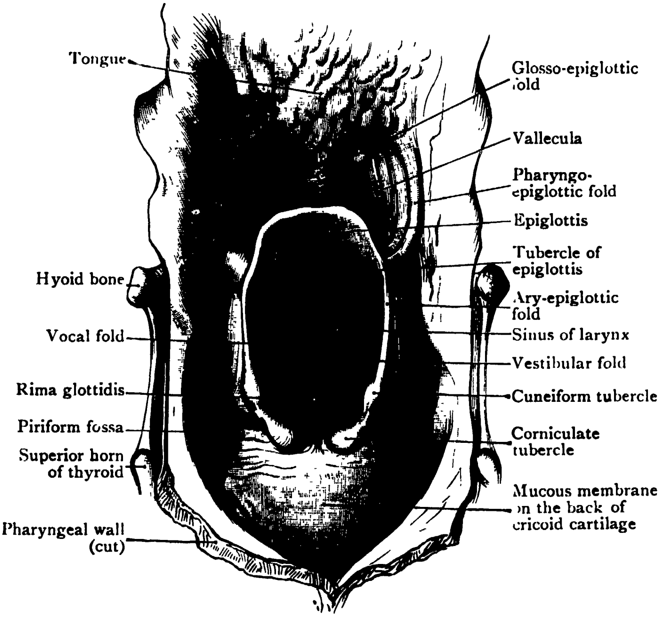


FIG. 112.—Anterior Wall of Laryngeal Part of Pharynx.

The **inlet of the larynx** is a large, oblique opening bounded above and in front by the epiglottis, on each side by the ary-epiglottic fold of mucous membrane, and postero-inferiorly by the interarytenoid fold of mucous membrane.

Each *ary-epiglottic fold* is a sharp, wide fold that extends downwards and backwards from the margin of the epiglottis to the arytenoid cartilage. It contains a muscle called the *ary-epiglotticus*; and, near its lower end, it contains two small pieces of cartilage which produce two little eminences—an upper or anterior called the *cuneiform tubercle*, and a lower called the *corniculate tubercle*.

The *arytenoid cartilages* are a pair of three-sided cartilages placed on the upper border of the lamina of the cricoid cartilage. The *interarytenoid fold* of mucous membrane passes between them; it forms the lower boundary of the inlet, and encloses the *arytenoid muscles*, which pass from the back of one arytenoid cartilage to the back of the other (Fig. 123).

The *piriform fossa* is the fairly deep hollow bounded medially by the arytenoid cartilage and the ary-epiglottic fold, and laterally by the mucous membrane that clothes the posterior part of the thyroid cartilage and thyro-hyoid membrane. It is of practical importance because foreign bodies may lodge in it, and, if sharp-pointed, may stick in its walls.

Below the level of the inlet, the mucous membrane of the anterior wall of the pharynx clothes the muscles that cover the backs of the arytenoid and cricoid cartilages—the arytenoid and posterior crico-arytenoid muscles—and is in contact with the posterior wall except when food is passing (Fig. 109).

The *œsophageal opening* is the narrowest part of the pharynx, and is opposite the lower border of the cricoid cartilage.

Soft Palate.—The soft palate is a movable curtain which extends downwards and backwards into the pharynx. During deglutition it is raised and helps to shut off the nasal part of the pharynx from the portion below. *Anteriorly*, it is attached to the posterior margin of the hard palate; *on each side*, it is connected with the side wall of the pharynx; and *posteriorly*, it presents a free border. The conical process, termed the *uvula*, hangs down from the middle of the free margin; and the sharp, concave part of the margin, on each side of the uvula, becomes continuous with the palato-pharyngeal arch. The *upper surface* of the soft palate is convex and continuous with the floor of the nasal cavities. The *inferior surface* is concave and forms part of the vault of the mouth. From the posterior part of the *inferior surface*, on each side, a palato-glossal arch curves downwards.

The soft palate is composed of a fold of mucous membrane whose two layers enclose muscular, aponeurotic, and glandular structures, together with blood-vessels and nerves. From above downwards, these structures are arranged as follows :—

(1) Mucous membrane, covered with ciliated epithelium.
(2) A layer of muscle.
(3) Palatine aponeurosis.
(4) Another layer of muscle.
(5) A great number of mucous *palatine glands*, which make up the greater part of the thickness of the soft palate.
(6) Mucous membrane, covered with stratified epithelium.

Palatine Aponeurosis.—This is a tendinous sheet that lies in the anterior two-thirds of the soft palate, and is attached to the crests on the lower surface of the bony palate near its posterior edge. It thins rapidly as it extends backwards, but near the bony palate, where muscle fibres are scanty, it is thick and strong ; the anterior part of the soft palate is therefore more horizontal and less movable than the posterior part.

MUSCLES OF SOFT PALATE.—They are :—the *levator palati* and *tensor palati*, which descend to the palate from the base of the skull ; the *palato-glossus* and *palato-pharyngeus*, which descend from it to the tongue and pharynx ; and the *musculus uvulæ*, which lies in its substance.

> ***Dissection*.—The dissection of the soft palate is difficult, and it is only in a fresh part that the precise relations of the different muscular layers can be made out. Begin by making it tense by means of a hook, and then carefully remove the mucous membrane from both surfaces, and also from the palato-glossal and palato-pharyngeal arches, and from the salpingo-pharyngeal fold, in order to expose the muscles within them.**

Palato-Glossus.—The palato-glossus forms a thin sheet in the lower part of the soft palate. Its fibres are partly continuous with those of the other side and are partly attached to the palatine aponeurosis. They converge to form a slender slip that descends in the palato-glossal arch to the back part of the side of the tongue, where most of it mingles with other lingual muscles, but a small bundle is inserted into the capsule of the tonsil.

When the two palato-glossi contract, they draw the tongue and soft palate closer together and also approximate the palato-glossal arches ; they thus assist in closing the oro-pharyngeal isthmus to prevent the return of food after it has passed from mouth to pharynx. The nerve supply is from the pharyngeal plexus by fibres derived from the accessory nerve.

Palato-Pharyngeus.—In the soft palate the palato-pharyngeus is divided into two parts separated by the levator palati. Both parts arise from the upper surface of the palatine aponeurosis, but the part postero-medial to the levator spreads out under the upper layer of mucous membrane and is partly continuous with the corresponding fibres of the opposite side. A portion of the other part soon detaches itself and curves backwards to mix with the fibres of the superior constrictor. All the rest of the fibres converge to form a small bundle that descends over the inner surface of the constrictor in the palato-pharyngeal arch. This bundle is joined by the salpingo-pharyngeus and stylo-pharyngeus, and most of it is inserted with them into the posterior border of the thyroid cartilage, but part of it spreads out to be attached to the pharyngo-basilar fascia. It is supplied by the accessory nerve through the pharyngeal plexus.

The two palato-pharyngei assist other muscles in elevating the pharynx and larynx during swallowing. They draw the two palato-pharyngeal arches close together like two curtains, and thus help to close the pharyngeal isthmus—the food passing down over the anterior surfaces of the approximated arches. The fasciculus that joins the superior constrictor assists that muscle in constricting the pharynx; and it is said to be specially developed in cases of cleft palate and to be an important factor in the closure of the isthmus.

Salpingo-Pharyngeus.—This very slender muscle arises by one or two slips from the lower border of the cartilage of the pharyngo-tympanic tube near its pharyngeal end. (*Salpinx* means a tube.) The muscle descends over the inner surface of the superior constrictor, in the salpingo-pharyngeal fold of mucous membrane, and joins the palato-pharyngeus.

M. Uvulæ.—The musculus uvulæ is in the form of a pair of slender slips that lie side by side under cover of the superficial fibres of the palato-pharyngeus. They arise from the posterior nasal spine, pass backwards through the soft palate, unite together and enter the uvula to be inserted into its mucous membrane.

It shortens the uvula; and it is supplied by the accessory nerve through the pharyngeal plexus.

> ***Dissection.***—**The levator palati muscle has been seen already on the outer side of the pharynx (Fig. 107). To display it from the inside remove the mucous membrane, the submucous tissue, and the pharyngo-basilar fascia from the uppermost part of the side wall of the pharynx; identify the muscle, and follow it down into the soft palate. In a well-injected specimen the terminal part of the ascending palatine artery will be seen descending along the levator palati into the soft palate.**

Levator Palati.—The elevator of the palate is a rounded, fleshy slip that arises from the quadrate area of the petrous temporal bone and from the medial surface of the cartilage of the pharyngo-tympanic tube. It passes downwards and forwards, crosses the upper border of the superior constrictor, pierces the pharyngo-basilar fascia, passes below the orifice of the tube, and enters the soft palate between the two parts of the palato-pharyngeus. There, its fibres spread out and are partly inserted into the palatine aponeurosis, but, posteriorly, the majority of the fibres become continuous with the corresponding fasciculi of the opposite side. The nerve supply is derived from the accessory nerve through the pharyngeal plexus.

Tensor Palati.—The tensor of the palate is a thin, flat, triangular muscle that ends inferiorly in a slender tendon. The muscle has been seen already in the medial wall of the infratemporal fossa (p. 183). It arises from the spine of the sphenoid, the lateral surface of the pharyngo-tympanic tube and the floor of the scaphoid fossa. The fibres converge on the tendon, which turns medially in a groove on the lower surface of the root of the pterygoid hamulus, and enters the palate. The tendon has a peculiar corrugated appearance; and a synovial bursa facilitates its play over the root of the hamulus. In the palate, the tendon expands and fuses with the palatine aponeurosis.

The tensor is supplied by the mandibular nerve through the otic ganglion.

Vessels and Nerves of Soft Palate.—The *ascending palatine branch* of the facial artery is the principal artery of supply. It ascends on the side wall of the pharynx to the upper border of the superior constrictor, and then descends with the levator to the palate. Its place may be taken by the *palatine branch* of the ascending pharyngeal artery. The *lesser palatine* branches of the greater palatine artery also contribute to the supply.

The *lesser palatine nerves* supply the mucous membrane. The tensor is supplied by the mandibular nerve; the other muscles are supplied by the accessory nerve by fibres that reach the pharyngeal plexus through the pharyngeal branch of the vagus.

Pharyngo-Tympanic Tube (Tuba Auditiva).—The pharyngo-tympanic tube is the canal through which air passes from the pharynx to the tympanic cavity, and thence to the tympanic antrum and mastoid air-cells. It is about an inch and a half long, and is divided into two portions according to its structure. Its *lateral half-inch*, which is near the tympanic cavity, has bony walls, for it runs in the interval between the tympanic and petrous portions of the temporal bone. The *medial part* consists mainly of cartilage. It is lodged in the gutter on the base of the skull between the petrous part of the temporal bone and the greater wing of the sphenoid. The cartilaginous part of the tube comes under the notice of the dissectors at the present stage, and they should first note its direction and then study its relations and the construction of its wall.

Ascertain its direction by passing a probe into it through its pharyngeal orifice. It runs backwards and laterally and slightly upwards, and passes first above and then to the lateral side of the levator palati, and along the medial side of the upper part of the tensor palati. It lies, therefore, in a considerable part of its extent, between the two muscles (Fig. 143).

Before removing the mucous membrane from the pharyngeal part of the tube, note that at the lower margin of the orifice there is a prominent rounded eminence, due to the subjacent levator muscle. The removal of the mucous membrane will reveal the fact that the wall of the tube is formed, in great part, by a triangular plate of cartilage, which is folded upon itself to form the upper and medial walls of the tube. The cartilage is deficient below and laterally, its place being taken by dense fibrous tissue which connects the margins of the cartilage and completes the wall of the canal. The base of this folded triangle of cartilage gives rise to the *tubal elevation*, already examined, on the side wall of the naso-pharynx (p. 283). The interior of the tube is lined with mucous membrane continuous with that of the pharynx and the tympanic cavity; and its calibre varies considerably in different parts of its course. It is narrowest at a point termed the *isthmus*, situated at the junction of the osseous and cartilaginous parts. As the tube is traced from the isthmus to the pharynx it gradually increases in calibre, and it attains its greatest width at its pharyngeal aperture.

Carotid Canal and Maxillary Nerve

The carotid canal is in the petrous part of the temporal bone, and contains the internal carotid artery, the internal carotid plexus of sympathetic nerves, and a plexus of veins.

> ***Dissection.*****—To open up the carotid canal, remove its inferior wall with the bone-forceps; but do not interfere with the pharyngo-tympanic tube, which lies in close proximity. The dissection must be made on one side only.**

Internal Carotid Artery.—The portion of the internal carotid artery which passes through the carotid canal is about three-quarters of an inch long. At first it ascends vertically; then, bending suddenly, it runs horizontally medially and forwards. It emerges from the canal at the apex of the petrous bone and enters the foramen lacerum, where it turns upwards, pierces the external layer of the dura mater, and enters the middle fossa of the skull. The remainder of the course of the internal carotid artery has been examined already (p. 117). Within the carotid canal it lies below and anterior to the cochlea and the tympanic cavity. The greater superficial petrosal nerve and the trigeminal ganglion are placed above it, but are separated from it by a thin plate of bone which, however, may be replaced by fibrous tissue.

Internal Carotid Nerve and Plexus.—The internal carotid nerve is a large branch which proceeds from the upper end of the superior cervical ganglion, and enters the carotid canal with the internal carotid artery. It soon divides into a number of branches which form the *internal carotid* *plexus* around the internal carotid artery; and the plexus ends by dividing into secondary plexuses that surround the anterior and middle cerebral arteries. The dissection of the branches can be satisfactorily effected only under specially favourable circumstances.

At the posterior end of the cavernous sinus, a *ganglion* is sometimes found in the plexus.

Branches.—The internal carotid plexus communicates with the tympanic plexus by means of *superior* and *inferior carotico-tympanic nerves* given off in the carotid canal, and with the spheno-palatine ganglion by the *deep petrosal nerve*, which unites with the greater superficial petrosal branch of the facial nerve to form the nerve of the pterygoid canal. It gives branches also to the trigeminal ganglion, the third, fourth, sixth nerves and ophthalmic division of the fifth nerve, and a branch which accompanies the naso-ciliary nerve into the orbit, where it joins the ciliary ganglion.

Maxillary Nerve.—The course of the maxillary nerve has been studied already in the macerated skull, and its continuation—the *infra-orbital nerve*—has been traced. The dissectors may now proceed to expose the nerve in the region which they are dissecting.

***Dissection.*—Remove the temporal muscle and the upper head of the lateral pterygoid muscle, and, placing the saw upon the cut margin of the skull at a point immediately above the external meatus, carry it obliquely downwards and forwards, through the squamous part of the temporal bone and the greater wing of the sphenoid, towards the medial end of the superior orbital fissure—entering that fissure immediately to the lateral side of the foramen rotundum. Make a second saw-cut from the cut margin of the cranial wall, immediately above the anterior margin of the greater wing, downwards into the superior orbital fissure to meet the first saw-cut. Remove the wedge-shaped piece of bone included between the cuts.**

To obtain additional space and to open up the pterygo-palatine fossa more fully, remove what remains of the greater wing of the sphenoid on the lateral side of the foramen rotundum, but preserve the circumference of that aperture.

The dissectors should now turn to p. 183 and re-read the account of the maxillary nerve and its branches.

They will then proceed to examine the cavity of the nose.

CAVITY OF NOSE

***Dissection.*—Remove the portion of the mandible which still remains (together with the tongue and larynx), from the upper part of the skull. From the angle of the mouth, on each side, carry the knife backwards through the buccinator and the mucous membrane and through the pterygo-mandibular ligament and the side wall of the pharynx. Cut the internal carotid**

artery, the smaller vessels which are still undivided and the nerves which still connect the pharynx with the skull. Wrap up the larynx and tongue and lay them aside for future dissection.

Divide the anterior part of the skull by a sagittal saw-cut close to one side of the nasal septum. The nasal septum usually deviates to one or other side. Pass a probe through the posterior aperture of the nose to find out to which side the septum bulges, and make the section close to its concave side. Begin anteriorly by introducing a knife into the nostril of that side, and carry it upwards through the cartilaginous part of the nose to the nasal bone. Then, place the specimen so that the face rests upon the table, and divide the soft palate in the median plane. Complete the section by sawing through the hard palate and bony roof of the nasal cavity at the side of the median plane, making every effort to preserve the septum of the nose intact.

Septum Nasi.—The septum of the nose divides the cavity into two narrow chambers—the right and the left cavity of the nose. It is seldom placed accurately in the median plane, but almost invariably bulges or deviates to one or other side (more frequently to the right). Immediately above the nostril, the septum shows a slight depression. That portion of the septum is the medial wall of the *vestibule of the nose*, and is clothed with skin from which a number of stiff hairs, termed *vibrissæ*, project into the cavity. The rest of the septum is covered with mucous membrane which is closely adherent to the subjacent periosteum and perichondrium; and it is separable into two districts, viz., a lower or *respiratory area*, and a much smaller upper or *olfactory area*—comprising not more than the upper third of the septum—in which branches of the olfactory nerve spread out. The respiratory mucous membrane is very thick and spongy. It is highly vascular and contains numerous *mucous glands*, the orifices of whose ducts can be detected by the naked eye. Over the olfactory district, the mucous membrane is softer and more delicate, and the glands are smaller. In the fresh state it has a yellowish colour.

Construction of Nasal Septum.—To expose the skeleton of the septum, strip off the mucous membrane. The chief constituents of its skeleton are:—(1) the vomer, below and behind; (2) the perpendicular plate of the ethmoid, above and behind; and (3) the septal cartilage, below and in front. Small portions of other bones take a minor part in its construction.

The **septal cartilage** fills up the wide, angular gap between the vomer and the perpendicular plate of the ethmoid, and it extends forwards towards the point of the nose. It is a broad, irregularly quadrilateral plate. Its *upper and posterior border* is in apposition with the anterior border of the perpendicular plate; and its *lower and posterior border*, much thickened, is received into the groove in the anterior border of the vomer and the nasal crest of the maxillæ. The angle between these two borders is prolonged backwards for a varying distance between the two plates of the vomer. The *upper and anterior border* of the septal cartilage is in contact, above, with the suture between the two nasal bones; below that, it is related to the upper pair of cartilages of the nose; and, still lower down, it occupies the interval between the medial parts of the lower pair of cartilages.

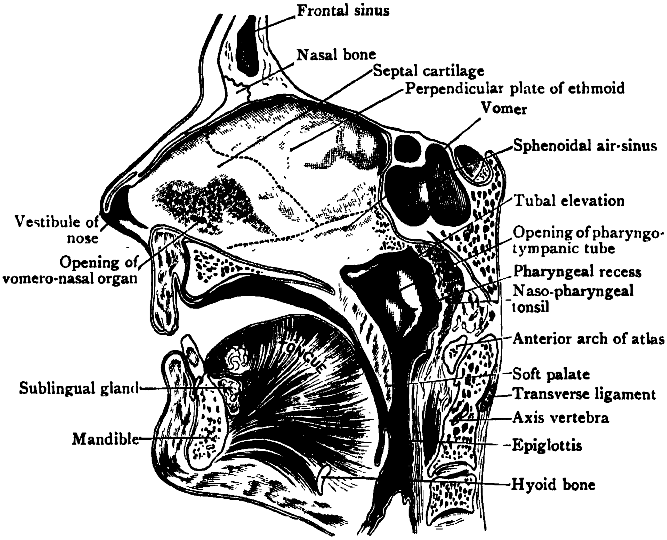


FIG. 113.—Sagittal Section through Nose, Mouth and Pharynx, a little to the left of the median plane.

Its connexion with the upper cartilage on each side is a very intimate one; indeed, below the nasal bones, the three cartilages are directly continuous, but lower down they are separated on each side by a fissure which runs upwards for some distance. The *lower and anterior border* is short and free, and extends backwards to the anterior nasal spine. The anterior angle of the septal cartilage is blunt and rounded, and does not reach the point of the nose, which is formed by the lower cartilages.

The deviation of the septum nasi from the median plane will now (in all probability) be seen to be due to a bulging of the vomer and perpendicular plate of the ethmoid along their line of union. As a rule, it is not developed until after the seventh year.

The smaller constituents of the septum are :—(1) The crest and rostrum of the sphenoid, above and posteriorly ; (2) the nasal spine of the frontal bone and the medial parts of the nasal bones, above and anteriorly ; (3) the septal part of the lower lateral cartilage, near the tip ; (4) the nasal crests of the maxillæ and palatine bones, inferiorly.

> ***Dissection.***—**Remove the septum piecemeal—but very carefully, in order to preserve intact the mucous membrane which clothes the opposite side of the septum. It is in that membrane that the nerves and blood-vessels must be examined.**

Vessels and Nerves of Septum Nasi.—The **nerves** of the septum are as follows :—

Nerves of Smell .	Olfactory (p. 304).
Nerves of Common Sensation . .	1. Spheno-palatine. 2. Branches of anterior ethmoidal nerve. 3. Twigs from the nerve of pterygoid canal.

The *long spheno-palatine nerve* (N. naso-palatinus) is a long, slender nerve that can easily be detected on the deep surface of the mucous membrane of the septum. It springs from the spheno-palatine ganglion, and enters the nasal cavity through the spheno-palatine foramen accompanied by the spheno-palatine branch of the maxillary artery. It first runs medially across the roof of the cavity ; then, changing direction, it passes downwards and forwards, in a groove on the surface of the vomer, to reach the floor of the nose, and thence through the incisive canal and median incisive foramen to end in the mucous membrane of the anterior part of the hard palate.

The *short spheno-palatine nerves* from the spheno-palatine ganglion and the twigs from the nerve of the pterygoid canal send filaments to the postero-superior part of the septum, which, however, are too slender to be found in an ordinary dissection.

The *medial nasal branches of the anterior ethmoidal nerve* will be found descending over the anterior part of the nasal septum. They may be traced as far as the vestibule.

The **arteries** which convey blood to the septum are branches of the spheno-palatine (p. 305), ethmoidal (p. 108) and superior labial arteries (Fig. 8).

> ***Dissection.***—**Disengage the nerves from the septum, in order that, afterwards, they may be traced to their origins. Then, with scissors, divide the mucous membrane along the roof of the nasal cavity and turn it down. When that is done, the opposite nasal cavity will be exposed.**

Cavity of Nose.—The cavity, as a whole, is divided by the septum into a right and a left half, and each half may be spoken of as a cavity of the nose.

Each cavity is about two inches in height and from two to three inches in length; but it is narrow from side to side, measuring half an inch or less at the floor, and only one or two millimetres at the roof. Its width is further reduced by the conchæ, which project into the cavity from the lateral wall.

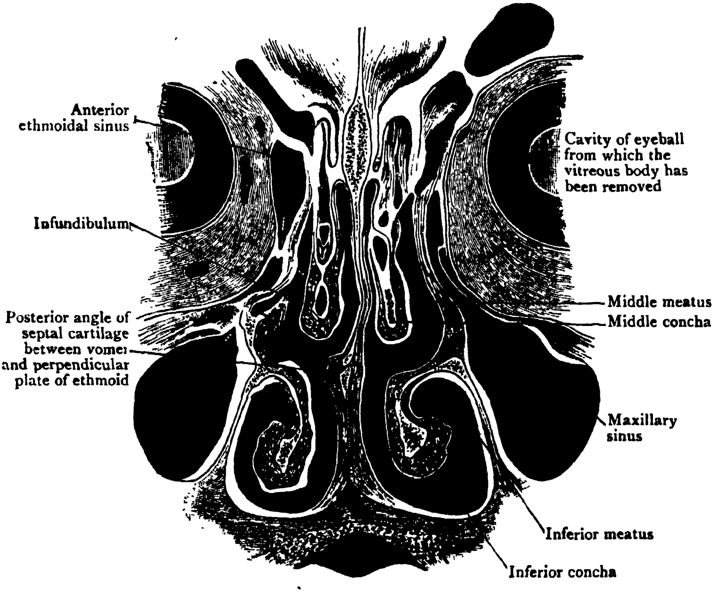

Anterior ethmoidal sinus
Infundibulum
Posterior angle of septal cartilage between vomer and perpendicular plate of ethmoid
Cavity of eyeball from which the vitreous body has been removed
Middle meatus
Middle concha
Maxillary sinus
Inferior meatus
Inferior concha

FIG. 114.—Posterior aspect of Coronal Section through Nasal Cavities and Crista Galli of Ethmoid Bone.

The *upper arrow* shows the opening of an anterior ethmoidal sinus into the hiatus semilunaris. The *lower arrow* passes from the maxillary sinus into the hiatus.

Each nasal cavity presents a medial wall formed by the septum, a lateral wall, a roof, a floor (Figs. 47, 114), and an anterior and a posterior aperture.

The **anterior apertures** or *nostrils* are a pair of oval orifices which open upon the face and look downwards. The **posterior apertures** open into the naso-pharynx and look backwards and downwards.

The **roof** is about three inches in length, but is very narrow from side to side. It is divisible into an anterior sloping part, a posterior sloping part and a middle part—the cribriform plate of the ethmoid—which is nearly horizontal.

The *anterior part* of the roof is formed by the nasal part of the frontal bone, by the nasal bone, and by the upper cartilage of the nose and the septal cartilage where they meet. The *posterior part* of the roof is composed of the anterior and inferior surfaces of the body of the sphenoid, and also of the ala of the vomer, the sphenoidal process of the palatine bone, and the vaginal process of the medial pterygoid lamina, all of which are applied to the inferior surface of the body of the sphenoid.

The **floor** is about two inches in length and barely half an inch in width. It is formed by the palatine process of the maxilla and the horizontal part of the palatine bones; it is concave from side to side and is slightly higher in front than behind.

The **lateral wall** of each nasal cavity is very uneven owing to the projection of the three conchæ.

The part which the different bones take in the formation of the lateral wall of the cavity of the nose must in the first place be studied in a sagittal section through the macerated skull, and the dissectors should constantly refer to such a preparation during the dissection. In front, it is formed by the upper and lower cartilages of the nose, the nasal bone, and the frontal process of the maxilla. Farther back, the lacrimal, the ethmoid, and the inferior concha, and a portion of the body of the maxilla, enter into its construction; and still farther back there are the perpendicular part of the palatine bone and the medial pterygoid plate. Placed in relation to the lateral wall there are the *ethmoidal air-sinuses*, which intervene between the upper part of the nasal cavity and the orbit, and, at a lower level, the *maxillary sinus* is situated immediately to the lateral side of the nasal cavity (Figs. 47, 114).

Turning now to the dissection, the dissectors will see that the lateral wall is separable into three areas. They are:—(1) the vestibule; (2) the atrium of the middle meatus; (3) the region of the conchæ and the intervening meatuses.

The **vestibule of the nose** (Figs. 113, 115) is the part immediately above the nostril, and its size and shape can be altered by the contraction of the nasal muscles. Its walls are lined with skin from which the stout hairs called *vibrissæ* grow. The anterior hairs incline backwards; the posterior hairs incline forwards; thus, the entrance into the nose is guarded by a filter-like arrangement of hairs.

The **atrium of the middle meatus** (Fig. 115) is above and slightly behind the vestibule, and immediately in front of the middle meatus. Its lateral wall is slightly concave;

and at its upper part, near the nasal bone, a feeble elevation termed the *agger nasi* may be noticed running downwards and forwards. It represents an additional concha which is present in some mammals.

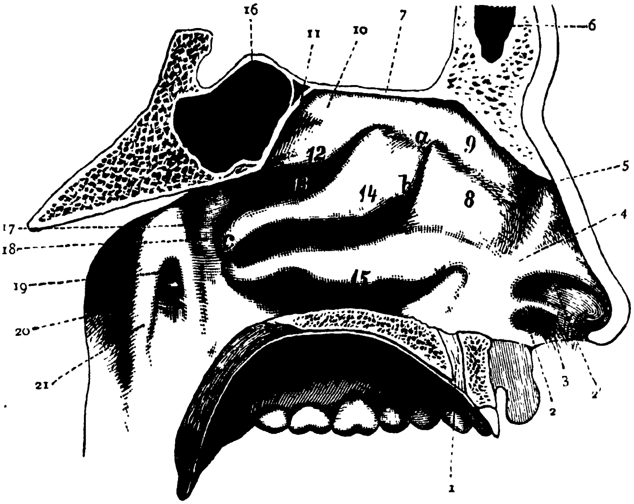


FIG. 115.—Lateral Wall of Left Nasal Cavity. (From Schwalbe.)

1. Incisive canal.
2, 2'. The two parts of the vestibular area.
3. Vibrissæ.
4. Elevation intervening between the vestibular district and the atrium.
5. Lower end of nasal bone.
6. Frontal air-sinus.
7. Cribriform plate of ethmoid.
8. Atrium of middle meatus.
9. Agger nasi.
10. Occasional concha suprema.
11. Spheno-ethmoidal recess.
12. Superior concha.
13. Superior meatus.
14. Middle concha.
15. Inferior concha.
16. Sphenoidal air-sinus.
17. Tubal elevation.
18. Posterior aperture of nose.
19. Orifice of pharyngo-tympanic tube.
20. Pharyngeal recess.
21. Posterior lip of tube.
a, *b*, *c*. Free border of middle concha.

Conchæ and Meatuses.—Behind the vestibule and the atrium there is the region of the conchæ and the meatuses. The conchæ are three curled bony plates that project into the cavity from the side wall and curve downwards. They are covered with thick mucous membrane. The upper two are processes of the ethmoid; the lower concha is an independent bone.

The **superior concha** (Fig. 115) is very short, and is placed on the upper and posterior part of the lateral wall of the cavity. Its free border begins a little below the middle of the cribriform plate, and passes obliquely downwards and backwards, to a point immediately below the body of the sphenoid, where it ends. The **middle concha** (Fig. 115) is much bigger and extends from the posterior aperture to the atrium. The **inferior concha** (Fig. 115) is slightly longer than the middle, and is about midway between the middle concha and the floor of the nose.

The **superior meatus** (Fig. 115) is a short narrow fissure between the superior and middle conchæ. The *posterior ethmoidal sinuses* open into its upper and anterior part by one aperture, or, sometimes, by several apertures.

To bring the apertures into view, introduce the blade of a pair of forceps under the superior concha, and force it upwards—taking care not to injure the mucous membrane more than is necessary.

The **middle meatus** is a much more roomy passage than the superior meatus; it extends backwards from the atrium, between the middle and inferior conchæ. To expose it, tilt the middle concha forcibly upwards and backwards.

The upper and anterior part of the middle meatus leads into a funnel-shaped passage called the *infundibulum*, through which the frontal sinus communicates with the cavity of the nose.

On the lateral wall of the middle meatus there is a deep, curved groove or gutter which begins at the infundibulum and runs from above downwards and backwards. The groove is termed the *hiatus semilunaris* (Fig. 116), and in it there are the openings of the *maxillary sinus* and *anterior ethmoidal sinuses*. The upper boundary of the hiatus semilunaris is prominent and bulging. It is termed the *bulla ethmoidalis*. On or above the bulla there is the aperture of the *middle ethmoidal sinuses*.

The orifice by means of which the maxillary sinus communicates with the middle meatus is in the medial wall of the sinus near its roof and is seen in the posterior part of the hiatus as a slit-like cleft. Sometimes, however, there is a second orifice, situated lower down, and it opens into the middle meatus immediately above the middle point of the attached margin of the inferior concha.

The dissectors should note that, on account of the relationship of the infundibulum to the hiatus semilunaris and of the hiatus to the opening of the maxillary sinus, there is a tendency for the secretion of the frontal sinuses to flow into the maxillary sinus. (See Fig. 116.)

The **inferior meatus** is the horizontal passage that separates the inferior concha from the floor and lateral wall of the nasal cavity. The naso-lacrimal duct opens into the anterior part of the inferior meatus near the attached border of the concha.

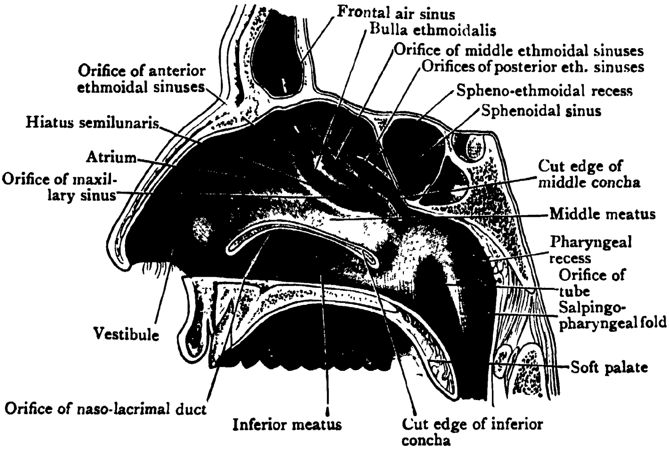

Frontal air sinus
Bulla ethmoidalis
Orifice of middle ethmoidal sinuses
Orifices of posterior eth. sinuses
Spheno-ethmoidal recess
Sphenoidal sinus
Orifice of anterior ethmoidal sinuses
Hiatus semilunaris
Atrium
Orifice of maxillary sinus
Cut edge of middle concha
Middle meatus
Pharyngeal recess
Orifice of tube
Salpingo-pharyngeal fold
Vestibule
Soft palate
Orifice of naso-lacrimal duct
Inferior meatus
Cut edge of inferior concha

FIG. 116.—Lateral Wall of Nasal Cavity and Naso-Pharynx. The three conchæ have been removed.

> ***Dissection.***—**To bring the aperture of the naso-lacrimal duct into view, remove a small portion of the anterior part of the inferior concha with the scissors; pass a probe upwards through the duct to confirm the statement that it is continuous with the lacrimal sac.**

The *orifice of the naso-lacrimal duct* varies in form. It may be wide, patent and circular; or the mucous membrane may be prolonged over the opening, reducing its size and acting as a flap-valve to the orifice. In some specimens the orifice is so minute that it is difficult to find it.

The space above and behind the superior concha is termed the **spheno-ethmoidal recess,** and in its posterior part the aperture of the *sphenoidal air-sinus* is seen (Fig. 116).

Muco-Periosteum of Lateral Wall of Nasal Cavity.—It has been noted that the vestibule is lined with skin. The remainder of the lateral wall is covered with mucous membrane which is so closely adherent to the periosteum that the two are inseparable and form a *muco-periosteum.* A similar membrane covers the roof and the floor. The muco-periosteum is continuous:—(1) through the naso-lacrimal duct, with the ocular conjunctiva; (2) through the various apertures, with the delicate lining membrane of the air-sinuses which open into the cavity; and (3), through the posterior apertures, with the pharyngeal mucous membrane.

On the lateral wall, as on the septum, the muco-periosteum is separable into an upper, olfactory, and a lower, respiratory portion; but the subdivision cannot be appreciated by the naked eye, for the one district passes into the other without any sharp line of demarcation. The *olfactory region* comprises merely the region of the upper concha; the *respiratory region* includes the rest. On the lower part, the muco-periosteum is thick and spongy, more particularly over the lower borders and posterior extremities of the middle and inferior conchæ, where the membrane presents an irregular surface and forms soft, bulging cushions. The spongy condition is due to rich venous plexuses; and in the region of the inferior concha the veins are so numerous that the muco-periosteum assumes the character of cavernous tissue. When turgid with blood it swells out and obliterates the interval between the concha and the septum. The muco-periosteum of the floor, meatuses and atrium, is smoother than that over the conchæ and is not so thick.

Everywhere, numerous *mucous glands* are embedded in it, and the orifices of the ducts are visible to the naked eye. In the olfactory region, the lining membrane of the nose, in the fresh state, is of a yellowish colour, and it is softer and more delicate than in the respiratory part.

The great vascularity of the mucous membrane of the nose is, doubtless, for the purpose of moistening and raising the temperature of the inspired air; and, to the same end, the conchæ, projecting into the nose, greatly increase the area of its mucous membrane.

Nerves and Vessels on Lateral Wall of Nasal Cavity.—The **nerves** are as follows :—

Nerves of Smell .	Olfactory nerves.
Nerves of Common Sensation . .	1. Branches of anterior ethmoidal. 2. Nasal branch of anterior superior dental. 3. Short spheno-palatine nerves from spheno-palatine ganglion and twigs from the nerve of the pterygoid canal. 4. Branches from the greater palatine nerve.

The *olfactory nerves* are from twelve to twenty in number. They are formed by numerous fine nerve filaments which spring from the olfactory cells of the olfactory mucous membrane. The nerve filaments lie in the muco-periosteum, and they are so soft that it is hardly possible to isolate them ; the nerves which they form are lodged in shallow grooves and small canals in the bones. At the roof of the nose the nerves pass through the foramina in the cribriform plate of the ethmoid ; they then pierce the meninges, from which they derive sheaths ; and they end in the lower part of the olfactory bulb.

Dissection.—Find the _long spheno-palatine nerve_ on the nasal septum, and trace it across the roof of the nasal cavity to the spheno-palatine foramen in the lateral wall. By dissecting carefully in the muco-periosteum in the neighbourhood of the foramen, in a good part, the dissector may be able to display one or more of the _short spheno-palatine nerves._ At the same time he should display the _spheno-palatine artery,_ which enters the nose through the spheno-palatine foramen.

The *short spheno-palatine nerves* are minute filaments that arise from the spheno-palatine ganglion and are accompanied by twigs from the nerve of the pterygoid canal. They enter the nose through the spheno-palatine foramen ; and they are distributed to the mucous lining over the posterior part of the septum, the upper and middle conchæ, the ethmoidal air-sinuses, and the side wall of the naso-pharynx.

Dissection.—Make a vertical incision through the muco-periosteum over the posterior part of the medial pterygoid plate ; carefully raise the membrane, reflect it forwards and seek for the nasal branches of the greater palatine nerve. They both pierce the perpendicular plate of the palate bone.

The *nasal branches of the greater palatine nerve* are two in number. They pierce the perpendicular part of the palatine bone, and supply the mucous membrane of the posterior parts of the conchæ.

The *anterior ethmoidal nerve* should be exposed as it descends in the groove on the deep surface of the nasal bone (p. 137). It gives branches to the anterior parts of the septum and lateral wall.

The main **artery** is the *spheno-palatine*—a branch of the maxillary. It gains entrance to the nasal cavity through the spheno-palatine foramen. Its septal branch accompanies the long spheno-palatine nerve ; others are distributed on the lateral wall of the cavity. Several twigs are given also by the *greater palatine branch* of the maxillary and the *two ethmoidal arteries*, but these are small and will be seen only when the injection has been unusually successful.

SPHENO-PALATINE GANGLION AND MAXILLARY ARTERY

The spheno-palatine ganglion is situated in the pterygo-palatine fossa ; and at this stage it can be exposed best by a dissection from the medial or nasal side.

Dissection.—The nasal branches of the greater palatine nerve have already been found piercing the perpendicular plate of the palatine bone. The plate is so thin there that the *greater palatine nerve* can be distinctly seen through it as the nerve descends in the greater palatine canal. By carefully opening up the canal with forceps or a small chisel, and following the greater palatine nerve upwards, the dissector will be led to the ganglion. The *long spheno-palatine nerve* should at the same time be traced to its origin. The *spheno-palatine ganglion* is so hemmed in by the walls of the fossa that it is very difficult to display it thoroughly ; but by removing the orbital process of the palatine bone, and a portion of the body of the sphenoid, with the bone-forceps, the dissector may expose it more or less satisfactorily. In the same restricted space the terminal portion of the *maxillary artery* will be found, from which numerous branches are given off.

Spheno-Palatine Ganglion.—The spheno-palatine ganglion is a small, triangular flattened body which is lodged in the upper part of the pterygo-palatine fossa opposite the spheno-palatine foramen. It is embedded in fat, and is surrounded by the terminal branches of the maxillary artery.

Roots.—It is suspended from the maxillary nerve by two stout *ganglionic branches* which descend to it from the nerve. But most of the fibres of those branches pass directly into the palatine and spheno-palatine nerves ; only a few of them enter the ganglion, and these few constitute the *sensory root* of the ganglion. The *sympathetic root* and the *secretory* or *parasympathetic root* are provided by the *nerve of the pterygoid canal*, which enters the back of the ganglion and is formed by the union of the greater superficial petrosal branch of the facial and the deep petrosal branch from the internal carotid sympathetic plexus. The only fibres of these roots that are relayed in the ganglion are the parasympathetic secretory fibres brought by the greater superficial petrosal nerve, and they include fibres for the lacrimal gland ; the other fibres pass through the ganglion into its branches.

Branches.—These are :—orbital, long and short spheno-palatine, greater palatine and pharyngeal.

The **orbital branches** are two or three very slender filaments that pass through the inferior orbital fissure to supply the periosteum of the orbit and the lacrimal gland.

The **long** and **short spheno-palatine nerves** pass through the spheno-palatine foramen to supply mucous membrane of the nose, and have been described already.

The **pharyngeal branch** passes backwards through the *palatino-vaginal canal* (canalis pharyngeus), accompanied by a branch of the maxillary artery. It supplies the mucous membrane of the roof of the pharynx and of the sphenoidal sinus.

Dissection.—The *greater palatine nerve* has been partly exposed in its canal. Remove its fibrous investment, and find the *lesser palatine nerves*, which spring from it and enter the lesser palatine canals. Then, turn to the lower surface of the palate in order to secure the nerves as they escape from the palatine foramina. Find the pterygoid hamulus. Dissect carefully in the soft tissues in front of it ; lift the soft tissues off the tubercle of the palatine bone, beginning at the medial side. The more medial of the lesser nerves is found first. Trace it backwards, deep to the tendon of the tensor palati, into the soft palate, dividing the tendon if necessary. The other lesser nerve is placed more laterally and may be absent. Next, secure the greater palatine nerve and vessels as they emerge through the greater palatine foramen, and trace them forwards.

Greater Palatine Nerve.—This is the largest branch of the spheno-palatine ganglion. It descends through the greater palatine canal, accompanied by the greater palatine branch of the maxillary artery ; it enters the palate through the greater palatine foramen, and runs forwards, in a groove on the lower surface of the bony palate, towards the incisive fossa, where it communicates with the terminal branches of the long spheno-palatine nerve. It supplies the gum, the mucous membrane and the glands of the vault of the mouth.

While tracing the greater palatine nerve in the palate, note the numerous mucous *palatine glands* which are placed under cover of the mucous membrane of the vault of the mouth, and the manner in which they indent the bone.

As the greater palatine nerve descends in its canal, it sends two *nasal branches* through the palatine bone to the mucous membrane of the nose (p. 304), and it gives off the two *lesser palatine nerves.*

The **lesser palatine nerves** descend through the lesser palatine canals. The more *medial* emerges through a small foramen immediately behind the palatine crest. It passes backwards above the tendon of the tensor palati into the substance of the soft palate to supply its glands and mucous membrane. There is some clinical evidence that it contains fibres for the musculus uvulæ derived from the facial nerve through the greater superficial petrosal nerve. The more *lateral* nerve, when present, supplies the mucous membrane of the soft palate near the tonsil.

Dissection.—The dissector will experience some difficulty in exposing the nerves in the palatino-vaginal and pterygoid canals, for these canals are very inaccessible. Identify them first in a dried skull and then in the part under dissection. Open them up with bone-forceps and examine the nerves that traverse them. The bone around the pterygoid canal is very hard and brittle, and the dissection must be effected with care.

The *nerve of the pterygoid canal* is described on p. 120.

Termination of Maxillary Artery.—The third part of the maxillary artery enters the pterygo-palatine fossa through the pterygo-maxillary fissure and breaks up into branches that accompany the nerves—infra-orbital, greater palatine, spheno-palatine, pharyngeal, and the nerve of the pterygoid canal—and receive the same names.

LARYNX

Remove the portions of the mandible which are still attached by mucous membrane to the sides of the tongue, and begin the dissection of the larynx.

Construction and Position.—The larynx is the upper, expanded portion of the wind-pipe which is specially modified for the production of the voice. Its walls are composed of cartilages, ligaments, membranes and muscles, and it has an internal lining of mucous membrane.

The larynx is placed in the upper part of the front of the neck, where it forms a marked projection. It lies below the hyoid bone and tongue, and is directly continuous with the trachea inferiorly. *Anteriorly* it is covered by the skin and fasciæ, and, on each side of the median plane, by two thin strata of muscles—viz., the sterno-hyoid and omo-hyoid ; the sterno-thyroid and thyro-hyoid. Frequently a narrow process of the thyroid gland, termed the *pyramidal lobe*, is continued upwards on its anterior surface. On *each side* a lobe of the thyroid gland is prolonged upwards on it, deep to the muscles ; and it is related to the great vessels of the neck. *Posteriorly* it is in relation to the pharynx, which separates it from the prevertebral muscles. If the tip of the epiglottis is taken as its upper limit, the larynx, in the adult, is in front of the third, fourth, fifth and sixth cervical vertebræ ; but the position is not fixed : it varies with the movements of the head, and also during deglutition and phonation.

Before proceeding with the dissection, the students should study the form and connexions of the nine laryngeal cartilages in a permanent specimen (p. 322); if possible, they should also procure two specimens of the larynx, and divide one by a median section in order that they may study the interior of the larynx before its dissection is begun.

Interior of Larynx.—The cavity of the larynx is smaller than might be expected from an inspection of its exterior. When its interior is examined from above, it will be seen to be subdivided into three portions by two pairs of elevated folds of mucous membrane which extend antero-posteriorly, and project inwards from the sides of the cavity. The upper pair of folds are termed the *vestibular folds* ; the lower pair receive the name of the *vocal folds*. The vocal folds are the chief agents in the production of the voice, and the larynx is so constructed that changes in their relative position, and in their degree of tension, are brought about by the action of the muscles and the recoil of the elastic ligaments.

Upper Subdivision of Laryngeal Cavity.—The upper subdivision is called the **vestibule** of the larynx (Figs. 112, 118). It extends from the inlet of the larynx down to the vestibular folds. The *inlet* was examined when the pharynx was dissected (p. 287). The lower part of the vestibule is compressed from side to side, and its width therefore diminishes from above downwards. Owing to the obliquity of the inlet, the anterior wall is longer than the posterior. The *anterior wall* is the epiglottis and the thyro-epiglottic ligament—both covered with mucous membrane. Each *side wall* of the vestibule is the ary-epiglottic fold of mucous membrane; for the most part the mucous membrane is smooth and slightly concave, but in its posterior part it bulges medially in the form of two vertical elevations, one behind the other. The anterior elevation is formed by the enclosed cuneiform cartilage and a mass of glands associated with it; the posterior elevation is due to the anterior margin of the arytenoid cartilage and the corniculate cartilage. A shallow groove (sometimes called the *philtrum vestibuli*) descends between the two elevations; it terminates below by running into the interval between the vestibular and vocal folds. The *posterior wall* of the vestibule is small and is formed by the interarytenoid fold of mucous membrane.

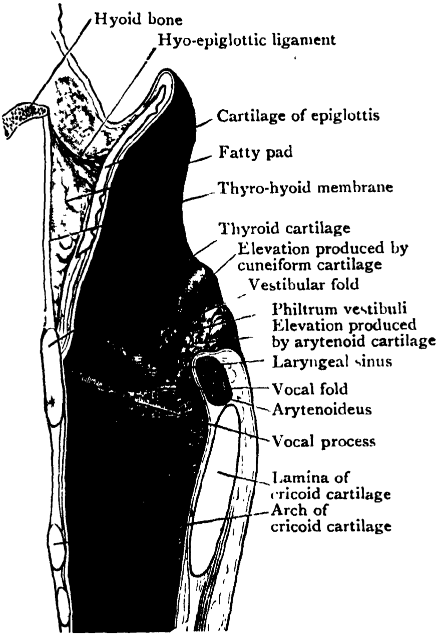


FIG. 117.—Median Section through Larynx, to show the Side Wall of its Right Half.

The *epiglottis* is set behind the median thyro-hyoid ligament, the hyoid bone and the back of the tongue. Its anterior surface is free only in its upper part, which is connected with the tongue by the *glosso-epiglottic fold.*

The posterior surface of the epiglottis is free, and forms the greater part of the anterior boundary of the vestibule of the larynx. The upper part of this surface is convex, owing to the manner in which the upper margin is curved towards the tongue; below the convexity there is a slight concavity; and still lower there is a marked bulging, called the *epiglottic tubercle*, which is a conspicuous object in laryngoscopic examinations.

Each *ary-epiglottic fold* of mucous membrane encloses some areolar tissue, the ary-epiglottic muscle, and, posteriorly, the cuneiform cartilage, and the corniculate cartilage, which surmounts the arytenoid cartilage. As already mentioned, the two small nodules of cartilage produce elevations on the medial layer of the posterior part of the ary-epiglottic fold, which are easily seen when the larynx is examined with the laryngoscope.

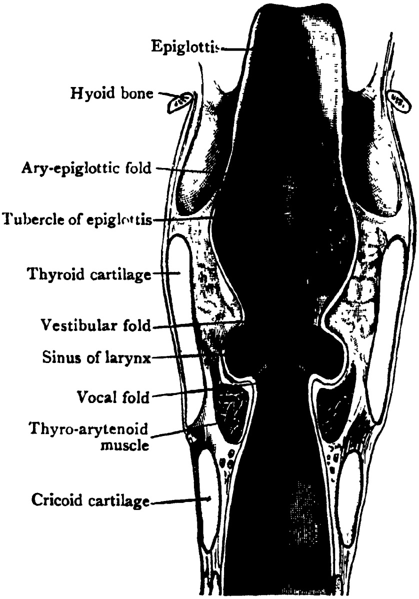


FIG. 118.—Coronal Section through Larynx, to show the Compartments.

Middle Subdivision of Laryngeal Cavity.—This is the smallest of the three sections. It is bounded above by the vestibular folds, and by the vocal folds below. (Fig. 118.)

Vestibular Folds (Plicæ Ventriculares).—Each of this pair of prominent folds of mucous membrane extends, anteroposteriorly, across the side wall of the laryngeal cavity. It is soft and rather flaccid, and its free border is slightly arched, with the concavity looking downwards. It contains:—(1) a vestibular ligament; (2) numerous mucous glands, which are aggregated chiefly in its middle part; and (3) a few muscle fibres. The interval between the vestibular folds is termed the *rima vestibuli*; it is considerably wider than that between the vocal folds. It follows, therefore, that both pairs of folds are visible when the cavity of the larynx is examined from above.

Vocal Folds.—Each vocal fold is sharp and prominent, and its mucous membrane is thin and is firmly bound down to the vocal ligament, which is enclosed within it. In colour it is pale—almost pearly white—whilst posteriorly where the fold ends the point of the vocal process of the arytenoid cartilage stands out in relief and presents a yellowish tinge. In coronal section, each vocal fold is prismatic in form, and the free border looks upwards and medially (Fig. 118).

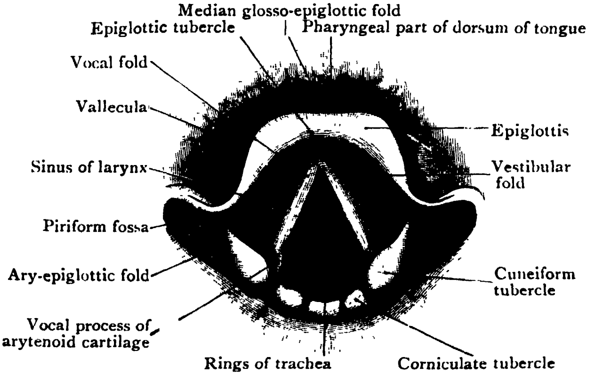


FIG. 119.—Cavity of Larynx, as seen with laryngoscope during quiet breathing—rima glottidis widely opened.

The vocal folds are the agents by means of which the voice is produced. The vestibular folds are of little importance in that respect; indeed, they can be destroyed, in great part, without any appreciable effect upon the voice.

Rima Glottidis.—The rima glottidis is the elongated fissure bounded on each side by the vocal fold and by the vocal process and base of the arytenoid cartilage. It is a little below the middle of the laryngeal cavity, and is the narrowest part of the cavity. The part between the folds is rather more than half of its length, and is narrower than the part between the cartilages. The form of the rima glottidis undergoes frequent alterations in the living person (Figs. 119-121). During ordinary quiet respiration it is lanceolate in outline, and the part between the folds has the form of an elongated triangle with the base directed backwards. When the rima glottidis is widely opened its broadest part is between the extremities of the vocal processes. The two vocal folds may, on the other hand, be approximated so closely to each other, as when a high note is sung, that the part between the folds is reduced to a chink. The length of the entire fissure is about an inch in men and two-thirds of an inch in women.

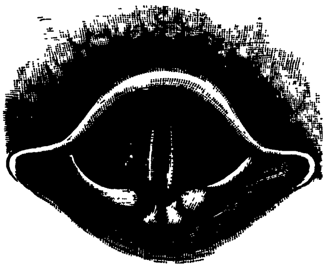


FIG. 120.—Cavity of Larnyx, as seen with laryngoscope during phonation—rima glottidis closed. (Cf. Fig. 119)

Sinus and Saccule of Larynx. — Between the

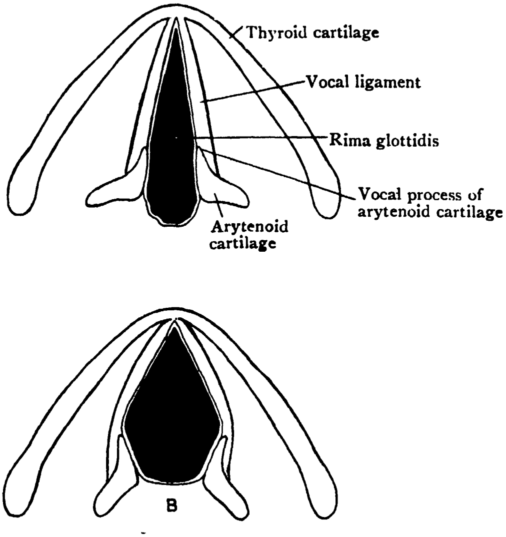


FIG. 121.—Diagram of Rima Glottidis.

A. During ordinary easy breathing. B. Widely open.

vestibular and the vocal folds, there is a deep, elliptical depression termed the *sinus of the larynx* (ventriculus). Examine the extent of the sinus with a blunt hook. It extends upwards, undermining the vestibular fold, and its mouth is narrower than its cavity. Under cover of the anterior part of the vestibular fold, a slit-like aperture will be detected. It leads into the *saccule of the larynx* (appendix ventriculi)—a small diverticulum which ascends between the vestibular fold and the lamina of the thyroid cartilage. The saccule is of variable extent, but, as a rule, it ends blindly at the level of the upper border of the thyroid cartilage. Large saccules and other laryngeal diverticula are characteristic of many apes and monkeys.

Distend the sinus, and, if possible, the saccule, with cotton wadding. This will greatly facilitate the subsequent dissection.

Lower Subdivision of Laryngeal Cavity (Fig. 118).—The part of the cavity below the rima glottidis leads directly downwards into the trachea. Above, it is narrow and compressed from side to side, but it gradually widens out until in its lowest part it is circular. It is bounded by the mucous membrane which covers the sloping, medial surface of a fibrous sheet called the crico-vocal membrane, and the inner surface of the cricoid cartilage. It is through the anterior wall of the lowest compartment of the larynx that the opening is made in the operation of laryngotomy.

Mucous Membrane of Cavity of Larynx.—Over the posterior surface of the epiglottis, the mucous membrane is closely adherent, but elsewhere, above the level of the vocal folds, it is attached loosely by submucous tissue to the adjacent structures. As it passes over the vocal folds, it is very thin and tightly bound down, and in inflammatory conditions of the larynx, attended with œdema, that attachment usually prevents the infiltration of the submucous tissue from extending downwards below the rima glottidis.

The mucous membrane is covered with stratified epithelium on the vocal folds and the upper parts of the epiglottis and ary-epiglottic folds ; elsewhere with columnar epithelium. It has a plentiful supply of racemose glands which secrete mucus, but in the vocal folds they are completely absent.

***Dissection.*—Place the larynx on a block so that its anterior surface looks upwards, and fix it in that position with pins.**

Trace the *external laryngeal nerve* into the *crico-thyroid muscle*. Clean that muscle, and preserve it. Identify the *internal* and *recurrent laryngeal nerves*, and preserve them. Then, remove the thyroid gland and the muscles attached to the outside of the larynx; clean the *crico-thyroid ligament* and the *thyro-hyoid membrane* and *ligaments*, and define their attachments.

Thyro-Hyoid Membrane and Ligaments.—The thyro-hyoid membrane is a broad membranous sheet which occupies the interval between the hyoid bone and the thyroid cartilage. It is not equally strong throughout, but shows a median thick portion called the *median thyro-hyoid ligament*, and cord-like right and left margins called the *lateral thyro-hyoid* ligaments; in the intervals between the median part and the margins it is thin and weak.

The **median thyro-hyoid ligament** is composed largely of elastic fibres. It is attached, inferiorly, to the sides of the deep, median notch on the upper border of the thyroid cartilage; it extends upwards, behind the body of the hyoid bone, to be attached to its *upper* border. The upper part of its anterior surface, therefore, lies behind the body of the hyoid bone; a synovial *bursa* is interposed between them to lessen friction when, in certain actions (*e.g.*, swallowing), the upper part of the thyroid cartilage is pulled upwards behind the hyoid bone.

On each side of the median part, the **thyro-hyoid membrane** is attached to the upper margin of the lamina of the thyroid cartilage, and stretches upwards, deep to the greater horn of the hyoid bone to be attached to its *upper* border. It is largely covered by the thyro-hyoid muscle, and its inner surface is lined with the mucous membrane of the piriform fossa of the pharynx. It is pierced by the internal laryngeal nerve and superior laryngeal vessels.

The **lateral thyro-hyoid ligament,** which forms the posterior border of the membrane on each side, is rounded and cord-like, and is composed chiefly of elastic fibres. It extends from the tip of the superior horn of the thyroid cartilage to the tip of the greater horn of the hyoid bone. In it there is usually developed a small, oval cartilaginous (or bony) nodule termed the *cartilago triticea* (Figs. 123, 128).

Crico-Thyroid Ligament.—This is a short, fairly broad band that extends from the median part of the cricoid arch to the lower part of the thyroid cartilage. Its median part is subcutaneous; each lateral part is overlapped by the crico-thyroid muscle, and is continuous with a wide membrane, called the crico-vocal membrane, which will be dissected later.

Intrinsic Muscles of Larynx.—These small muscles are named as follows:—

1. Crico-thyroid.
2. Posterior crico-arytenoid.
3. Lateral crico-arytenoid.
4. Thyro-arytenoid.
5. Thyro-epiglottic.
6. Transverse arytenoid.
7. Oblique arytenoid.
8. Ary-epiglottic.

All the intrinsic muscles of the larynx are supplied by the recurrent laryngeal nerve, except the crico-thyroid, which is supplied by the external laryngeal nerve, and is distinguished further by the fact that it is the only one of them that lies on the exterior of the larynx.

The **crico-thyroid muscle** bridges over the lateral portion of the crico-thyroid interval. It takes origin from the arch of the cricoid cartilage, whence its fibres spread out in an upward and backward direction, and are inserted into the inferior horn and lower margin of the thyroid lamina. A tendinous arch overlies its posterior part near its insertion and gives origin to some of the lower fibres of the inferior constrictor. The crico-thyroid muscles are the chief tensors of the vocal ligaments.

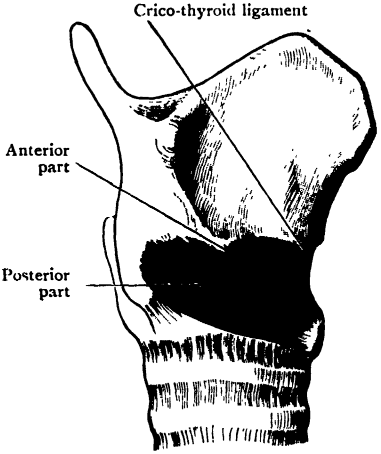


FIG. 122.—Crico-Thyroid Muscle.

Dissection is required for the display of the other intrinsic muscles.

Dissection.—**Reverse the position of the larynx. Fix it on the block with its posterior surface uppermost. Open the *œsophagus* by a median incision through its posterior wall. Next, remove the mucous membrane from the back of the cricoid and arytenoid cartilages. While doing that, bear in mind that the *inferior laryngeal artery* and the *recurrent laryngeal nerve* pass**

upwards between the thyroid and cricoid cartilages, and must be preserved.

On the back of the cricoid cartilage, note the two *posterior crico-arytenoid muscles*, and the attachment between them of the tendinous band by which the œsophagus is fixed to the cricoid cartilage. On the back of the arytenoid cartilages, and bridging across the interval between them, are the *transverse* and *oblique arytenoid muscles*. Take special care while the oblique muscles are being cleaned, in order that the connexions of the decussating fibres may be ascertained fully.

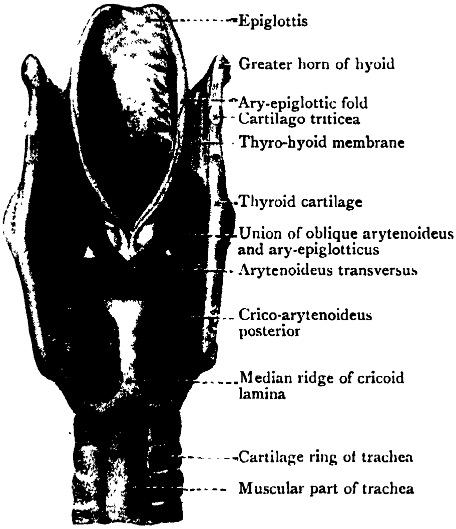


FIG. 123.—Muscles of Back of Larynx.

Remove the lateral layer of the left ary-epiglottic fold cautiously to expose the *ary-epiglottic muscle*, the *cuneiform cartilage*, and the *corniculate cartilage*. This is perhaps the most difficult part of the dissection, because the fibres of the ary-epiglotticus are thin and sparse, and the dissector has to establish their continuity with the fibres of the oblique arytenoid muscle (Fig. 123).

Each **posterior crico-arytenoid** muscle (Fig. 123) springs, by a broad origin, from the back of the cricoid cartilage, and its fibres converge to be inserted into the ***muscular process*** of the arytenoid cartilage.

It is an abductor of the vocal fold; and the pair of muscles therefore widen the rima glottidis.

The **transverse arytenoid** muscle is the only unpaired muscle in the larynx. It is a thin, flat band that passes from the back of one arytenoid cartilage to the back of the other.

The **oblique arytenoid** muscles are a pair of feeble slips that lie on the back of the transverse muscle, and cross each other like the limbs of the letter X. Each arises from the muscular process of one arytenoid cartilage, and passes obliquely to the apex of the other. Some of the fibres are inserted into the apex of the arytenoid, but most of them are prolonged into the ary-epiglottic fold. There, they are called the **ary-epiglottic muscle,** which proceeds upwards to be inserted into the margin of the epiglottis.

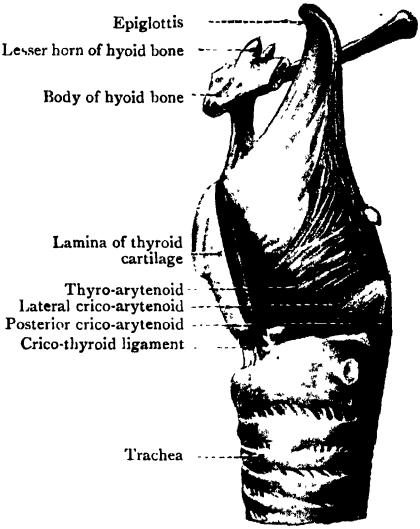


FIG. 124.—Side View of Muscles of Larynx. The fibres passing backwards and upwards from the upper border of the thyro-arytenoid muscle are the fibres of the thyro-epiglotticus.

These muscles help to close the inlet of the larynx during swallowing; for the arytenoid muscles draw the arytenoid cartilages closer together, and the ary-epiglottic muscles draw these cartilages towards the epiglottis.

***Dissection.*—Confine the further dissection of the laryngeal muscles to the left side of the larynx. Reserve the right side for the study of the nerves and vessels.**

Place the larynx on its right side, and, having fixed it, remove the left crico-thyroid muscle. Divide the left part of the thyro-hyoid membrane, and disarticulate the left inferior horn of the thyroid cartilage. Cut through the left lamina of the thyroid cartilage near the median plane, and remove the detached piece carefully.

Clean the three muscles now exposed. From below upwards,

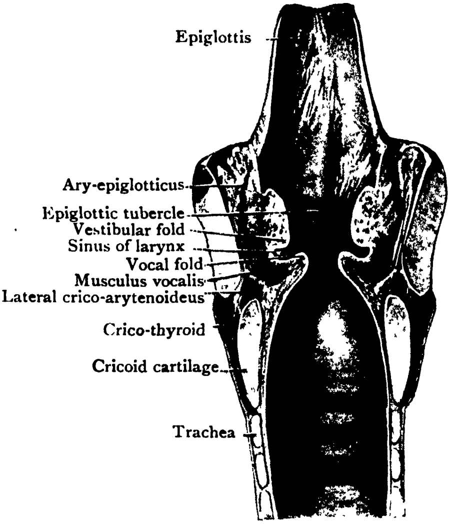


FIG. 125.—Coronal Section of Larynx, showing Muscles.

they are the *lateral crico-arytenoid*, the *thyro-arytenoid*, and the *thyro-epiglotticus*.

Each **lateral crico-arytenoid** muscle (Fig. 124) springs from the upper border of the side of the cricoid arch; its fibres run backwards and upwards, and converge to be inserted into the muscular process of the arytenoid cartilage. The superficial surface of the muscle is covered by the lamina of the thyroid cartilage and the upper part of the crico-thyroid muscle; its deep surface is applied to the crico-vocal membrane.

The lateral crico-arytenoid muscles are adductors of the vocal folds, and therefore reduce the width of the rima glottidis.

The **thyro-arytenoid** muscle is a muscular sheet that springs from the deep surface of the thyroid lamina close to its anterior border, and passes backwards to be inserted into the antero-lateral surface of the arytenoid cartilage. It pulls the arytenoid cartilage forwards, and slackens the vocal fold.

The uppermost fibres of the thyro-arytenoid muscle, when they reach the arytenoid cartilage, curve upwards into the ary-epiglottic fold. They are called the *thyro-epiglottic muscle*, and join with the ary-epiglottic muscle to be inserted into the edge of the epiglottis.

Some of the deepest fibres of the thyro-arytenoid—those stretching from the thyroid cartilage to the lateral side of the vocal process—form a bundle called the **vocalis muscle**, though it cannot be separated from the rest of the muscle except by artificial means. It lies along the lateral side of the vocal ligament and the upper part of the crico-vocal membrane, and some of its fibres arise from the vocal ligament.

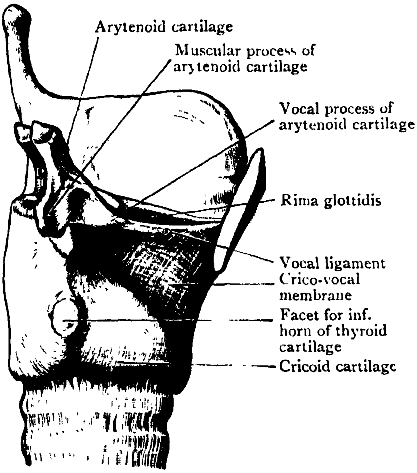

Arytenoid cartilage
Muscular process of arytenoid cartilage
Vocal process of arytenoid cartilage
Rima glottidis
Vocal ligament
Crico-vocal membrane
Facet for inf. horn of thyroid cartilage
Cricoid cartilage

FIG. 126.—Crico-Vocal Membrane and Vocal Ligament.

Dissection.—**Remove the lateral crico-arytenoid muscle carefully. Remove also the superficial part of the thyro-arytenoid muscle ; isolate the *vocalis* muscle, and then remove it. The lateral surface of the *crico-vocal membrane*, the *vocal ligament*, and the wall of the *laryngeal sinus* are then displayed. Clean them carefully, and look for the feeble bundle called the *vestibular ligament* amidst the mucous glands that lie between the layers of the vestibular fold.**

Crico-Vocal Membranes (Conus Elasticus).—The crico-vocal membranes are a pair of thin sheets of fibro-elastic tissue that slope upwards and inwards from the sides of the cricoid arch. The superficial surface of each membrane is covered by the lateral crico-arytenoid muscle and the thyro-arytenoid muscle, including the vocalis. Its deep surface is lined with the mucous membrane of the interior of the larynx. It is triangular in outline. The lower border is oblique, and is attached to the sloping, upper margin of the cricoid arch. The anterior border is partly continuous with the crico-thyroid ligament, and, above that, is attached to the deep surface of the thyroid cartilage near the anterior angle. The superior border is divisible into two parts: the posterior part is attached to the lower surface of the vocal process of the arytenoid cartilage; the anterior part is longer, and is a free edge called the *vocal ligament.*

Vocal and Vestibular Ligaments.—The **vocal ligament** is not an isolated band, but is the thickened anterior part of the upper border of the crico-vocal membrane; and it is composed almost entirely of elastic tissue. It lies within the vocal fold, to which it gives support; and it is closely bound to the mucous membrane of the fold. Its posterior end is attached to the tip of the vocal process of the arytenoid cartilage; its anterior end is attached to the deep surface of the thyroid cartilage opposite the middle of the anterior border, close to its fellow of the other side.

The **vestibular ligament** (lig. ventriculare) is a feeble band of loose fibro-elastic tissue that lies amidst the mucous glands in the vestibular fold. It is attached posteriorly to the antero-lateral surface of the arytenoid cartilage, and anteriorly to the deep surface of the thyroid cartilage near the anterior angle—a little above the vocal ligament and immediately below the thyro-epiglottic ligament.

***Dissection.*—On the left side of the larynx, remove the remains of the ary-epiglottic fold, the vestibular and vocal folds, and the crico-vocal membrane, but be careful not to injure the arytenoid cartilage or the corniculate cartilage. If the cuneiform cartilage is present in the ary-epiglottic fold, it should be detached and preserved.**

By this dissection a good view of the side wall of the laryngeal cavity can be obtained.

Examine the right vocal fold, which is undissected; explore the laryngeal sinus and saccule, and determine their precise connexions and extent. When the dissectors have satisfied themselves about those points, they can proceed to display the vessels and nerves of the larynx.

Dissection.—The *superior laryngeal artery* and the *internal laryngeal nerve* reach the pharynx by piercing the thyro-hyoid membrane and they descend along the lateral wall of the piriform fossa to the larynx. Apply traction to the nerve, and follow its branches downwards, dividing the mucous membrane ; clean the artery at the same time.

The *inferior laryngeal artery* and *recurrent laryngeal nerve* enter from below and proceed upwards, under cover of the lamina of the thyroid cartilage. They can be satisfactorily displayed only by the removal of that piece of cartilage, but the dissectors are not recommended to do that unless another larynx is available for the examination of the cartilages and joints. If the thyroid cartilage is drawn laterally the more important branches can be studied.

Nerves and Vessels of Larynx.—In the dissection of the Neck, the **internal laryngeal nerve** was seen springing from the superior laryngeal branch of the vagus. It is a *sensory* nerve, and its branches are distributed chiefly to the larynx, where it supplies the mucous membrane of the exterior, and also of the interior down to the vocal folds.

After piercing the thyro-hyoid membrane, the superior laryngeal nerve divides into three branches. The *upper branch* sends filaments to the mucous membrane of the epiglottis and all its folds, and to the lower median part of the back of the tongue. The *middle branch* supplies the mucous membrane that lines the side wall of the larynx. The *lower branch* supplies the mucous membrane on the side and back of the arytenoid and cricoid cartilages, and communicates with the recurrent laryngeal nerve.

In the neck, the **recurrent laryngeal nerve** was traced up to the point where it disappears under cover of the lower border of the inferior constrictor muscle, and enters the larynx. It is the *motor* nerve of the larynx. It supplies all the muscles, with the exception of the crico-thyroid, which obtains its nerve-supply from the external laryngeal. It contains a few sensory fibres also. Those it gives to the lining mucous membrane of the larynx below the rima glottidis.

The recurrent laryngeal nerve, having entered the larynx, ascends on the side of the cricoid cartilage, immediately behind the crico-thyroid joint. There, it is joined by a branch of the internal laryngeal nerve, and almost immediately afterwards it divides into two branches. The *anterior branch* is the larger of the two ; it proceeds upwards, under cover of the lamina of the thyroid cartilage, and breaks up to supply the lateral crico-arytenoid, the thyro-arytenoid, the vocalis and the thyro-epiglottic muscles. The *posterior branch* inclines upwards and backwards under cover of the posterior crico-arytenoid muscle ; it supplies that muscle and the arytenoid muscles.

The **superior laryngeal artery**, a branch of the superior thyroid, accompanies the internal laryngeal nerve; the **inferior laryngeal artery**, which springs from the inferior thyroid, accompanies the recurrent nerve. The two vessels ramify to supply the structures in the laryngeal wall.

CARTILAGES, JOINTS AND LIGAMENTS OF LARYNX.—The cartilages which constitute the skeleton of the larynx and give support to its wall are the following:—

1. Thyroid,	single.	4. Arytenoid,	paired.
2. Cricoid,		5. Corniculate,	
3. Epiglottic,		6. Cuneiform,	

They are connected by certain ligaments; and the thyroid and arytenoid cartilages articulate with the cricoid cartilage by two pairs of synovial joints—the *crico-thyroid* and the *crico-arytenoid*.

***Dissection.*—Remove the mucous membrane and muscles carefully from the cartilages, and define the ligaments. Exercise great caution while cleaning the arytenoid and corniculate cartilages, in order that the latter may not be injured.**

Epiglottic Cartilage.—This is a thin, leaf-like lamina of yellow fibro-cartilage placed behind the tongue and the body of the hyoid bone, in the anterior boundary of the inlet and vestibule of the larynx. When divested of the mucous membrane, the cartilage of the epiglottis has the form of an obovate leaf; and it shows numerous pits and perforations. Glands are lodged in the pits, and the foramina transmit vessels and nerves. The broad end of the cartilage is directed upwards, and is free; its lateral margins are to a large extent enclosed within the ary-epiglottic folds. The anterior surface is free only in its upper part. That part is covered with mucous membrane, and looks towards the tongue. The posterior surface is covered with mucous membrane throughout its whole extent. The lower end of the cartilage is pointed, and is connected with the thyroid cartilage by the *thyro-epiglottic ligament*.

The epiglottis is bound by mucous folds and by ligaments to the base of the tongue, to the side wall of the pharynx, to the hyoid bone, and to the thyroid cartilage.

The *glosso-epiglottic fold* and the two *pharyngo-epiglottic folds* have been studied already (p. 286).

The *hyo-epiglottic ligament* is a short, broad band of loose fibro-elastic tissue which connects the anterior face of the epiglottic cartilage to the upper border of the body of the hyoid bone. The *thyro-epiglottic ligament* is strong, elastic and thick, and attaches the lower end of the cartilage to the back of the thyroid cartilage a little below the median notch.

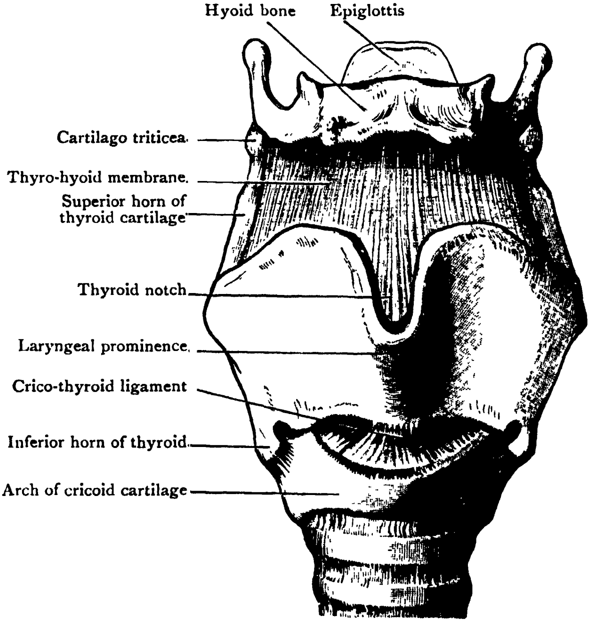


FIG. 127.—Anterior aspect of Cartilages and Ligaments of Larynx

The triangular interval between the lower part of the epiglottis and the median thyro-hyoid ligament contains a pad of soft fat, and it is imperfectly closed above by the hyo-epiglottic ligament.

Thyroid Cartilage.—The thyroid cartilage is the largest of the laryngeal cartilages ; and the relatively larger size of the larynx in men—which is a well-known secondary sex character—is manifested best by the thyroid cartilage. It is in the form of a pair of broad, quadrilateral *laminæ* which are fused together in front but are widely separated behind.

The *anterior borders* of the laminæ are fused only in their lower parts. Above, they are separated by a deep, narrow V-shaped *thyroid notch.* In men, the angle formed by the meeting of the anterior borders of the two laminæ, especially in the upper part, is very projecting; and, with the margins of the notch, it makes the marked, subcutaneous *laryngeal prominence,* colloquially known as "Adam's apple."

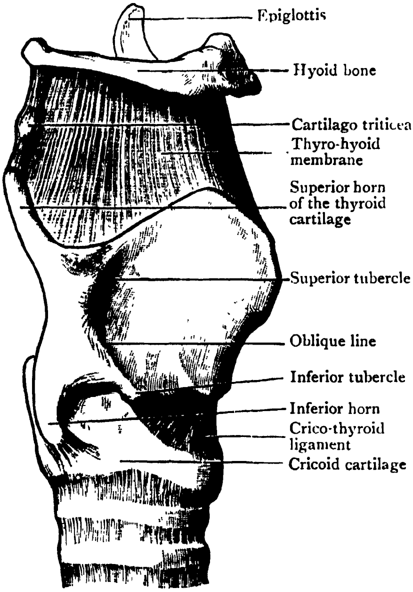


FIG. 128.—Profile View of Cartilages and Ligaments of Larynx.

The *posterior border* of each lamina is thick and rounded, and is prolonged upwards and downwards as two processes termed the horns. The *superior horn* gives attachment to the lateral thyro-hyoid ligament. The *inferior horn* is shorter and thicker and curves slightly medially, and the medial side of its tip articulates with the side of the cricoid cartilage.

The *superior border* of the lamina is for the most part slightly convex, and anteriorly it dips down to become continuous with the margin of the thyroid notch. The *inferior border* is almost horizontal, and has a small projection on it, termed the *inferior tubercle,* a little behind its middle.

The *lateral surface* of the lamina is relatively flat. Immediately below the posterior part of the upper border, and in front of the root of the superior horn, there is a prominence called the *superior tubercle.* From that point an *oblique ridge* descends towards the inferior tubercle. The ridge gives attachment to the sterno-thyroid and thyro-hyoid muscles and to the inferior constrictor of the pharynx, which arises also from the area behind the ridge.

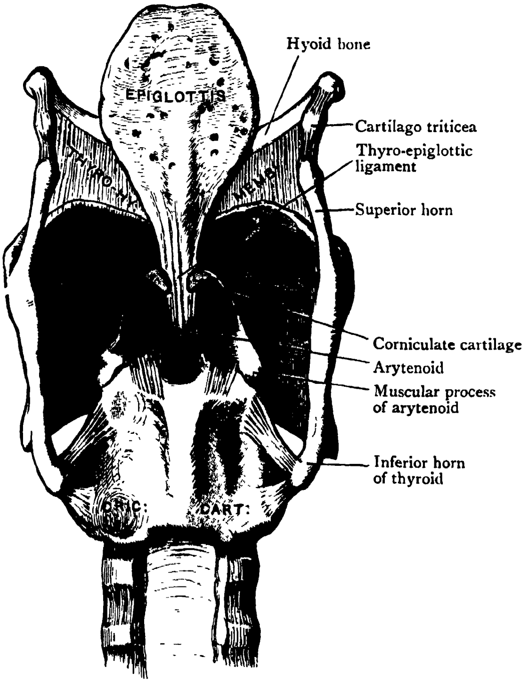


FIG. 129.—Posterior aspect of Cartilages and Ligaments of Larynx.

The *medial surface* of the lamina is smooth and slightly concave. It is lined with mucous membrane, and several structures are attached to it at and near the anterior border—the thyro-epiglottic ligament, the vestibular and vocal ligaments, and the thyro-arytenoid and vocalis muscles.

Crico-Thyroid Joint.—This is the articulation between the inferior horn of the thyroid cartilage and the side of the cricoid cartilage. It is a synovial joint, and has therefore a capsular ligament lined with synovial membrane. The movements which take place are:—(1) gliding in various directions; and (2) rotatory movement around a transverse axis which passes through the centres of the right and left joints.

> ***Dissection.*—Divide the ligaments which surround the crico-thyroid joint, and remove the thyroid cartilage.**

Cricoid Cartilage.—The cricoid cartilage is shaped like a signet-ring. The broad, posterior part, called the *lamina*, is quadrangular in outline. Its upper border is occupied by a pair of oval, convex facets separated by a shallow notch; these facets articulate with the bases of the arytenoid cartilages. The posterior surface of the lamina is divided by a median ridge into two areas which give origin to the posterior crico-arytenoid muscles. The median ridge itself gives attachment to a tendinous band which proceeds upwards from the longitudinal fibres of the œsophagus. The anterior part of the cricoid cartilage is the *arch*. Its upper border slopes rapidly upwards as it passes backwards to the lamina, and gives attachment to the crico-thyroid ligament and crico-vocal membrane.

The facet for the thyroid is on the side of the ring at the junction of arch and lamina. The lower border of the ring is horizontal, and is connected to the first tracheal ring by a circular ribbon called the *crico-tracheal ligament*; and the inner surface of the ring is lined with mucous membrane.

The arch of the cricoid cartilage lies below the anterior part of the thyroid cartilage, but the lamina is received into the interval between the posterior portions of the thyroid laminæ.

Begin the study of the arytenoid cartilages by noting their relation to each other and to the cricoid cartilage. Then, remove one cartilage and examine its surfaces and borders. Retain the other cartilage in position for the purpose of examining the crico-arytenoid joint and its movements.

Arytenoid Cartilages.—These are a pair of three-sided pyramids that rest on the upper border of the lamina of the cricoid cartilage. The *apex* of each is directed upwards, and it curves backwards and medially; and it supports the corniculate cartilage. The *base* articulates with the upper border of the cricoid lamina. The postero-lateral angle of the base is thick and projecting, and is called the *muscular* *process* because the crico-arytenoid muscles are inserted into it. The anterior angle of the base is prolonged forwards as a pointed spine called the *vocal process* because the vocal ligament is attached to its tip.

The surfaces of the cartilage are medial, posterior and antero-lateral. The *medial surface* is narrow, vertical and even, and is clothed with mucous membrane. The *posterior surface* is concave, and gives attachment to the arytenoideus transversus. The *antero-lateral surface* is the most extensive of the three, and is uneven for the attachment of the thyro-arytenoid and vocalis muscles and the vestibular ligament.

Crico-Arytenoid Joints.—Each crico-arytenoid joint is a synovial joint; its cavity is surrounded by a capsular ligament lined with synovial membrane. The movements allowed at the joint are:—(1) *gliding*, by which the arytenoid advances towards its fellow or retreats from it; (2) *rotatory*, by which the arytenoid cartilage rotates around a vertical axis, swinging the vocal process laterally or medially so as to open or close the rima glottidis.

The capsule is strengthened posteriorly, and forward movement of the arytenoid cartilage is thus restricted.

Corniculate and Cuneiform Cartilages.—The corniculate cartilages are a pair of small conical nodules of yellow fibro-cartilage. Each is placed in the posterior end of the ary-epiglottic fold, on the apex of the arytenoid, and points backwards and medially. It is either fused with the arytenoid or attached to it by fibrous tissue.

The cuneiform cartilages are a pair of little rod-shaped nodules of yellow fibro-cartilage. Each is placed in the ary-epiglottic fold in front of the corniculate cartilage (Fig. 117). They are not always present.

Actions of Laryngeal Muscles.—The dissectors should now consider the manner in which the muscles of the larynx operate upon the vocal folds in the production of the voice.

Tension of the vocal folds is produced by the contraction of the *crico-thyroid muscles*. The anterior parts of the muscles pull the upper border of the cricoid arch upwards, and the posterior portions draw the cricoid cartilage backwards, thereby increasing the distance between the angle of the thyroid cartilage and the vocal processes of the arytenoid cartilages. When the crico-thyroid muscles cease to contract, the relaxation of the vocal folds is brought about by the elasticity of the ligaments. The vocalis and the thyro-arytenoid muscles must be regarded as antagonistic to the crico-thyroid muscles. When they contract they pull the arytenoid cartilages towards the angle of the thyroid cartilage and still further relax the vocal folds ; and when they cease to act, the elastic ligaments of the larynx again bring about a state of equilibrium.

The *width of the rima glottidis* is regulated by the arytenoid and crico-arytenoid muscles. The posterior crico-arytenoid muscles draw the muscular processes backwards, rotating the arytenoid cartilages on vertical axes so that the right and left vocal processes and folds are swung apart and the rima glottidis is widened. The lateral crico-arytenoid muscles act in the opposite way. They draw the muscular processes forwards so that the vocal processes and folds move medially to close the anterior part of the rima. At the same time the arytenoid muscles draw the arytenoid cartilages towards each other to close the posterior part.

But the thyro-epiglottic and ary-epiglottic muscles, aided by the arytenoid muscles, have a different function to perform. During swallowing, they close the inlet of the larynx by drawing the arytenoid cartilages together and pulling them up into close contact with the tubercle of the epiglottis. It was once thought the epiglottis was a lid that folded down to close the inlet of the larynx during swallowing, but a mere examination of the specimen will show that the movable part of the epiglottis is not big enough to close the opening ; and investigations carried out last century (chiefly by Anderson Stuart) showed that the epiglottis stood upright during swallowing and that the food glided down over the back of the epiglottis and over the back of the approximated ary-epiglottic folds and arytenoid cartilages on to the back of the cricoid cartilage and thence into the gullet.

THE TONGUE

The tongue is a mobile organ which lies in the floor of the mouth. It consists of a mass of muscle covered with mucous membrane and interspaced with a small amount of fat and some glands. It is closely associated with the functions of taste, chewing, swallowing and speaking.

It has the form of a shoe turned upside down. The opening of the shoe corresponds with the *root* of the tongue; through it there pass the muscles which connect the tongue with the hyoid bone and the mandible (Figs. 132, 133).

Besides the root, the tongue has a tip, margins, lower surface and dorsum. The *tip* and *margins* lie against the teeth and the gums. The *lower surface* is related to the floor of the mouth. The *dorsum* is divided into two parts—palatine and pharyngeal—by a V-shaped groove called the *sulcus ter-* the limbs of the V diverge widely; the apex points backwards and is marked by a pit called the *foramen cæcum*. The *palatine part* of the dorsum looks upwards, and is the part visible in the living mouth. The *pharyngeal part* is the back of the tongue; it forms the anterior wall of the lower part of the oral pharynx, and is related to the epiglottis. (The term "base" is better not used for the back of the tongue, for it is apt to be confused with the root.)

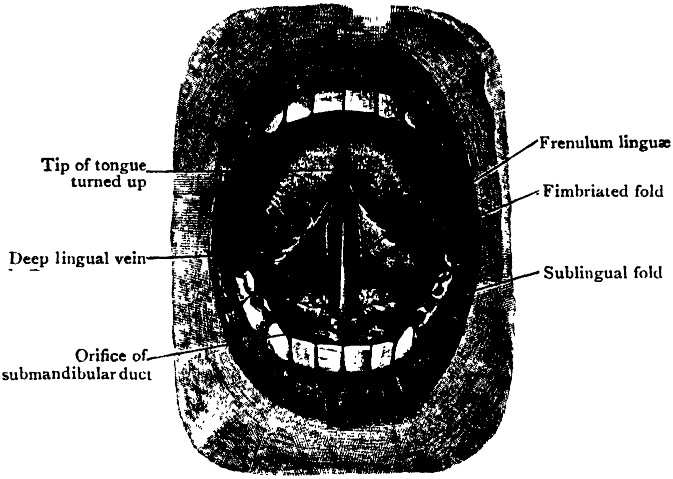


FIG. 130.—Lower Surface of Tongue.

Mucous Membrane of Tongue.—The mucous membrane is continuous with the general lining of the mouth and pharynx, but presents very different appearances on different areas of the tongue.

On the lower surface of the tongue, the mucous membrane is smooth and comparatively thin; in the median plane, it is raised up to form the *frenulum linguæ,* which has been studied at an earlier stage. On each side of the median line, the *deep lingual vein* may be noticed, in the living subject, extending forwards towards the tip. To the lateral side of the vein there is a delicate and feebly marked ridge of mucous membrane from the free border of which a row of fringe-like processes or fimbriæ project. It is termed the *fimbriated fold*; as it extends forwards it inclines towards the median plane (Fig. 130).

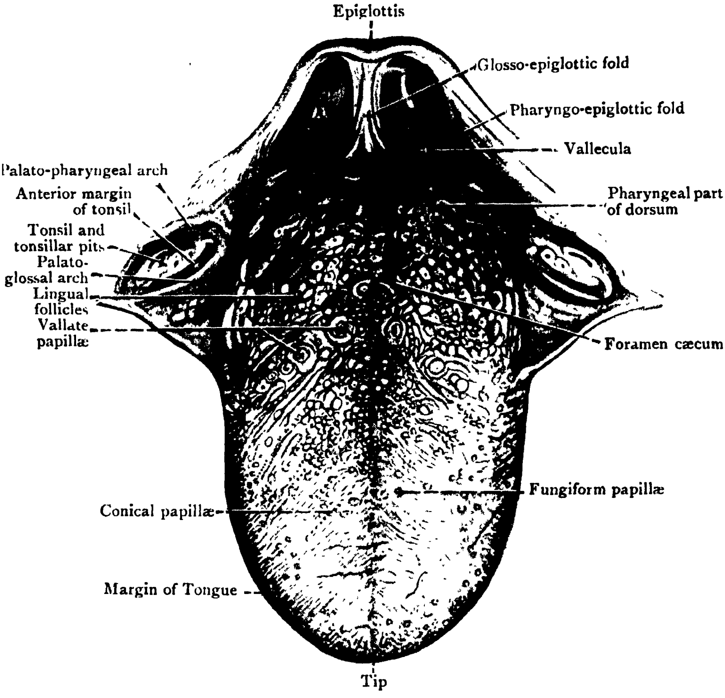


FIG. 131.—Tonsils and Dorsum of Tongue. (D. Waterston)

On the side of the tongue, immediately in front of the lingual attachment of the palato-glossal arch, five short vertical folds in the mucous membrane may be noticed. They are called the *folia linguæ* (papillæ foliatæ), and are the representatives of leaf-like folds of the mucous membrane which are much more highly developed in certain of the lower animals (hare and rabbit), and are specially concerned in receiving the impressions of taste.

The mucous membrane of the **pharyngeal part** of the dorsum is smooth and glossy, but it is studded with low elevations produced by masses of lymph-follicles embedded in the submucous tissue ; and in each elevation there is usually a small central pit. As the mucous membrane passes from the tongue to the epiglottis, it is raised into a small median fold called the *glosso-epiglottic fold*.

The mucous membrane of the **palatine part** of the dorsum is studded with papillæ of different kinds. As these are individually visible to the naked eye, the mucous membrane presents a very characteristic roughened appearance. Further, a shallow median groove extends from the tip of the tongue to the foramen cæcum, and divides the palatine part of the dorsum into halves.

Lingual Papillæ.—The papillæ are of three kinds, and differ in size, shape and in the position they occupy on the surface of the tongue. They are termed the vallate, the fungiform and the filiform.

The *vallate papillæ*, seven to twelve in number, are the largest, and are placed immediately in front of the sulcus terminalis. In form, a vallate papilla is a short cylinder ; it is sunk in a pit, and is thus surrounded by a deep trench.

The *fungiform papillæ* are much smaller, but are much more numerous. They are the bright red spots seen in the living tongue, and are seen chiefly on the tip and margins ; but they are scattered, at irregular intervals, over the upper surface also. Each papilla is rounded and knob-like, and is greatly constricted at the point where it springs from the mucous surface.

The *filiform papillæ* are present in very large numbers. They are minute pointed projections that occupy the margins and the whole of the palatine part of the dorsum. They are arranged in closely set parallel rows. On the posterior part, the rows diverge from the median groove in an antero-lateral direction ; towards the tip of the tongue the rows become more or less transverse and on the margins they are arranged one above the other. A pocket-lens will show that the apex of some of the filiform papillæ is broken up into thread-like processes.

Muscles of Tongue.—The tongue is composed almost entirely of muscular fibres, with some adipose and glandular and fibrous tissue intermixed. It is divided into halves by a median fibrous septum; and the muscles of each half consist of an intrinsic and an extrinsic group. They are as follows :—

Extrinsic	*Intrinsic*
1. Genio-glossus.	1. Superior longitudinal.
2. Hyo-glossus.	2. Inferior longitudinal.
3. Stylo-glossus.	3. Vertical.
4. Palato-glossus.	4 Transverse.

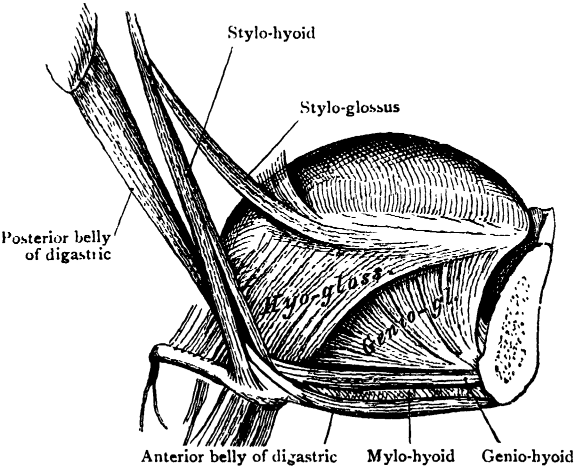


FIG. 132.—Extrinsic Muscles of Tongue. (Gegenbaur)

The **extrinsic muscles** take origin from parts outside the tongue, and can therefore move the tongue as well as alter its shape. The **intrinsic muscles,** being wholly inside the tongue, can only produce changes of shape.

The extrinsic muscles have been studied already, but the dissectors should now take the opportunity of examining their insertions more fully, and the manner in which their fibres are related to one another and to those of the intrinsic muscles.

Dissection.*—Carefully reflect the mucous membrane from the right half of the tongue, and follow the muscles into that side of it. At the same time, preserve the lingual nerve and the deep artery. On the under surface of the tongue, near the tip, the removal of the mucous membrane and a layer of muscle will expose a small, oval glandular mass called the *anterior lingual gland.

The *stylo-glossus* will be seen running along the side of the tongue to the tip. The *hyo-glossus* extends upwards to the side of the tongue, and its fibres pass, for the most part, under cover of those of the stylo-glossus to reach the dorsum, over the posterior part of which they spread out beneath the mucous membrane. The *genio-glossus* sends its fibres upwards into the tongue on each side of the median septum, and its insertion stretches from the tip to the back. The fibres of the *palato-glossus* become continuous with the intrinsic transverse fibres.

The *superior longitudinal muscle* lies immediately beneath the mucous membrane, and is a continuous layer of longitudinal fibres which covers the entire dorsum of the tongue.

The *inferior longitudinal muscles* are a pair of rounded, fleshy bundles in the lower part of the tongue. Posteriorly, each lies in the interval between the hyo-glossus and the genio-glossus, and is attached to the hyoid bone; anteriorly, it is prolonged to the apex of the tongue between the medial border of the stylo-glossus and the genio-glossus, and is more or less blended with the stylo-glossus.

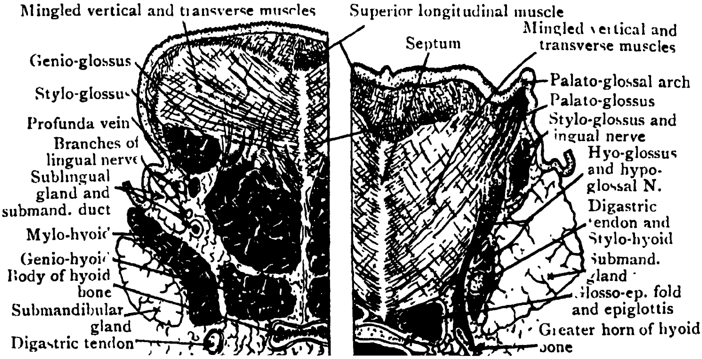

Mingled vertical and transverse muscles
Genio-glossus
Stylo-glossus
Profunda vein
Branches of lingual nerve
Sublingual gland and submand. duct
Mylo-hyoid
Genio-hyoid
Body of hyoid bone
Submandibular gland
Digastric tendon
Superior longitudinal muscle
Septum
Mingled vertical and transverse muscles
Palato-glossal arch
Palato-glossus
Stylo-glossus and lingual nerve
Hyo-glossus and hypo-glossal N.
Digastric tendon and Stylo-hyoid
Submand. gland
Glosso-ep. fold and epiglottis
Greater horn of hyoid bone

FIG. 133.—A. Section through Tongue and body of Hyoid Bone.
B. Section through Tongue and greater horn of Hyoid Bone.

The fibres of the *transverse muscle* lie under the superior longitudinal fibres, and constitute a thick layer which extends from the septum to the side of the tongue. The fibres of the genio-glossus ascend through the transverse stratum and break it up into numerous lamellæ. It is joined by the fibres of the palato-glossus.

The fibres of the *vertical muscle* extend in a curved direction, downwards and laterally, from the dorsum towards the lower part of the tongue, and decussate with the fibres of the transverse muscle.

Septum of Tongue.—The septum can be seen best in a transverse section through the organ (Fig 133). Such a section will, in a measure, display also the transverse and vertical muscular fibres. The septum is a median fibrous partition. It is strongest posteriorly, where it is attached to the hyoid bone. It does not reach the dorsum of the tongue, being separated from the mucous membrane by the superior longitudinal muscle.

Glands of Tongue.—Small *mucous glands* lie under the mucous membrane of the pharyngeal surface and at the tip and margins. Small *serous glands* lie near the vallate papillæ and open into their trenches. The *anterior lingual gland* is really a group of serous and mucous glands. It is an oval mass about the size of a large pea. It lies in the lower part of the tongue near the median plane and not far from the tip, and is covered with the mucous membrane and a layer of muscle.

Nerves of Tongue.—The nerves are:—(1) the glosso-pharyngeal, to the mucous membrane of the posterior third of the tongue; (2) the lingual, to the mucous membrane of the anterior two-thirds; (3) the hypoglossal, to the muscles; and (4) a few twigs from the internal laryngeal to the pharyngeal surface and the glosso-epiglottic and pharyngo-epiglottic folds.

They should be traced on the left side of the tongue, where the mucous membrane is still in position.

The *glosso-pharyngeal nerve* has been traced up to the point where it disappears under cover of the hyo-glossus muscle. There it divides into two branches. The *smaller* of the two may be traced forwards on the side of the tongue as far as the middle. The *larger* branch turns upwards, and is distributed to the mucous membrane of the posterior third of the dorsum of the tongue and the anterior surface of the epiglottis.

The *lingual* and *hypoglossal nerves* are described on pages 181, 199, 201; their terminal branches should now be traced as far as is possible.

Blood-Vessels of Tongue.—The chief **arteries** are branches of the lingual (p. 202)—the *deep artery of the tongue* to the anterior part, and the *dorsales linguæ* arteries to the posterior part. The posterior part receives twigs also from the tonsillar branch of the facial. Follow the deep artery to the tip, where it is connected by an anastomotic loop with the deep artery of the other side. That is the only anastomosis between the arteries of the two halves of the tongue—except through the network of capillaries.

The **veins** are described on p. 203.

Lymph-Vessels of Tongue.—These cannot be seen in an ordinary dissection; but, as the tongue is often the seat of malignant disease, it is important that the student should take note of the situations of the groups of lymph-glands that receive the lymph from the tongue (Fig. 134).

The lymph-vessels of the tongue arise from a rich capillary plexus in the mucous membrane; and they end in the **submental, submandibular** and **deep cervical** lymph-glands. The vessels are arranged in four groups—anterior, middle, posterior and central.

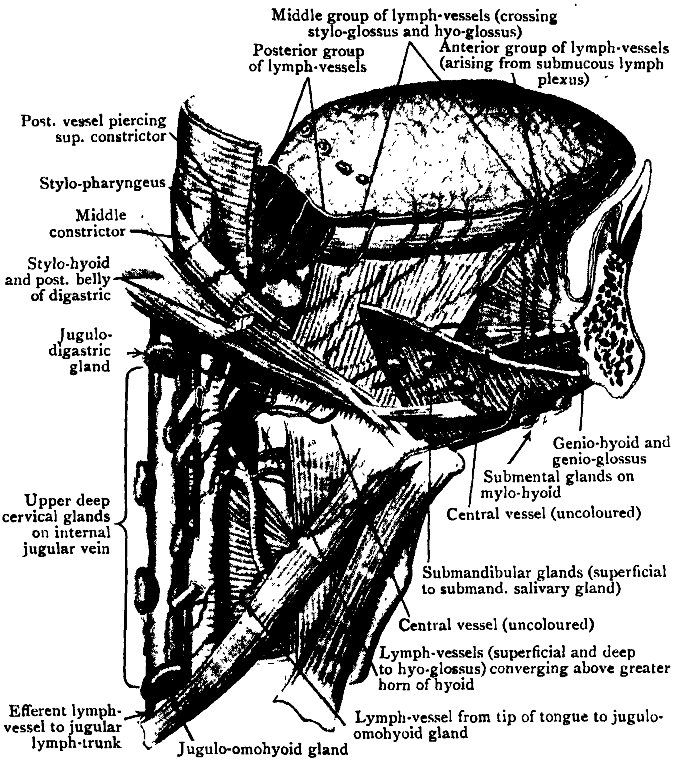

Middle group of lymph-vessels (crossing stylo-glossus and hyo-glossus)
Posterior group of lymph-vessels
Anterior group of lymph-vessels (arising from submucous lymph plexus)
Post. vessel piercing sup. constrictor
Stylo-pharyngeus
Middle constrictor
Stylo-hyoid and post. belly of digastric
Jugulo-digastric gland
Upper deep cervical glands on internal jugular vein
Efferent lymph-vessel to jugular lymph-trunk
Jugulo-omohyoid gland
Genio-hyoid and genio-glossus
Submental glands on mylo-hyoid
Central vessel (uncoloured)
Submandibular glands (superficial to submand. salivary gland)
Central vessel (uncoloured)
Lymph-vessels (superficial and deep to hyo-glossus) converging above greater horn of hyoid
Lymph-vessel from tip of tongue to jugulo-omohyoid gland

FIG. 134.—Diagram of the Course of the Lymph-Vessels of Tongue.

Only one central vessel is shown (uncoloured). Central vessels and one or more of the posterior group may cross the median plane and end in deep cervical glands of the opposite side.

The *anterior vessels* drain the tip and the inferior (free) surface. They pierce the mylo-hyoid muscle and end in the submental lymph-glands—all except one vessel which passes the submental glands, crosses the hyoid bone and ends in a deep cervical gland placed on the internal jugular vein at the lateral margin of the omo-hyoid muscle—the jugulo-omohyoid gland.

The *middle vessels* drain the anterior two-thirds of the dorsum and margins (except the tip). They pass downwards, at different depths, to end in the submandibular and deep cervical glands. Those that end in the submandibular glands pass superficial to the sublingual salivary gland and pierce the mylo-hyoid muscle. Others run in a deeper plane, over both surfaces of the hyo-glossus, and end in the part of the chain of deep cervical glands that stretches through the carotid triangle—from the digastric muscle to the omo-hyoid.

The *posterior vessels*—larger than the others—drain the posterior third of the dorsum. They first run backwards beneath the mucous membrane, and then turn laterally to pierce the wall of the pharynx below the tonsil; they also end in the chain in the carotid triangle—principally in a gland on the internal jugular vein at the lower border of the digastric—the jugulo-digastric gland.

The *central vessels* arise in the dorsal plexus near the median plane. They descend between the genio-glossi, and are joined by the vessels from the deep parts of the tongue. They then run laterally and backwards, with the veins of the tongue, and end in the glands in the carotid triangle.

Note that any of the deep cervical glands in the carotid triangle may receive lymph-vessels direct from the tongue; and that, in general, the farther forward the origin of the vessel the lower down is the gland in which it ends. Note also that some members of the anterior, posterior and central groups cross the median plane to end in glands of the opposite side.

AUDITORY APPARATUS

THE organ of hearing admits of a very natural division into three parts, viz., the external ear, the middle ear and the internal ear.

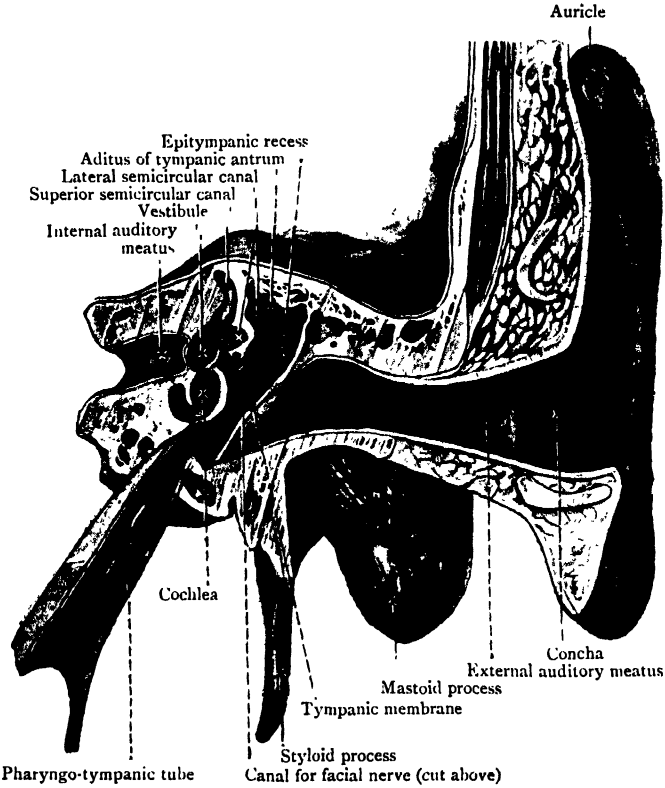


FIG. 135.—The Parts of the Ear (semi-diagrammatic). The purple colour indicates the mucous lining of the various parts.

The *external ear* comprises the auricle and the external auditory meatus. The auricle collects the waves of sound, and is, comparatively speaking, of little importance in man, although it is of considerable service in some of the lower animals. The external auditory meatus is a passage leading medially from the bottom of the concha of the auricle to the tympanic membrane, which separates the external ear from the middle ear. The *middle ear* is a narrow chamber whose cavity is termed the *tympanic cavity*. It is interposed between the external auditory passage and the internal ear; and the main part of its lateral wall is formed by the tympanic membrane. Stretching across the cavity of the tympanum, from its lateral to its medial wall, there is a chain of three small bones called the auditory ossicles. The *internal ear* is the most essential part of the organ. It consists of a complicated system of cavities enclosed in dense bony envelopes called the bony labyrinth, which is situated in the densest part of the petrous portion of the temporal bone, and contains a number of membranous tubes and sacs called the membranous labyrinth.

EXTERNAL EAR

The auricle has been examined already (pp. 2, 12). The dissectors will now expose the external meatus.

***Dissection.*—The dissection of the ear should be conducted differently on opposite sides.**

On one side remove the lateral pterygoid plate and the remains of the pterygoid muscles, if that has not been done already. Then, clear away the tensor palati and expose the lateral surface of the *pharyngo-tympanic tube*. Dissect on the postero-medial side of the tube and expose the levator palati from the lateral side; follow it downwards and medially, below the lower orifice of the tube, into the soft palate. Detach the tube from the medial pterygoid plate; cut the levator palati at the point where it enters the soft palate, and separate the cartilaginous part of the tube from any parts of the wall of the pharynx which may still be connected with it.

Turn to the temporal bone; place the saw at right angles to the external surface of the squamous part and saw through the bone, along the line of the squamo-tympanic fissure, to the posterior border of the spine of the sphenoid. Turn next to the medial surface and saw through the body of the sphenoid at the level of the anterior boundary of the foramen lacerum; then, with the aid of the chisel and bone-forceps, detach the posterior border of the greater wing of the sphenoid from the anterior border of the petrous part of the temporal bone.

When the dissection is properly done the greater part of the temporal bone is removed from the remainder of the skull, with the cartilaginous part of the pharyngo-tympanic tube attached to the anterior margin of its petrous portion, and a small part of the body of the sphenoid bone attached to its apex. The anterior wall of the articular fossa was separated by the first saw-cut, but the posterior wall is still present, with the cartilaginous part of the tube attached to its medial end and the cartilaginous part of the external meatus attached to its lateral border.

Dissection.—**Cut away the tragus of the auricle to expose the orifice of the external meatus; then, with knife or scissors, remove the anterior wall of the cartilaginous part of the meatus.**

Next, pass a probe into the bony part of the meatus to gauge its length; and, while the probe is kept in position as a guide, cut away the anterior wall of the bony part of the meatus, taking care not to injure the tympanic membrane.

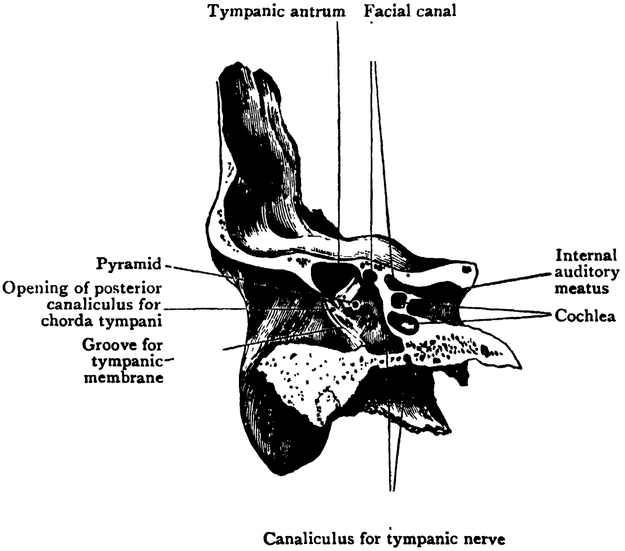

Tympanic antrum
Facial canal
Pyramid
Opening of posterior canaliculus for chorda tympani
Groove for tympanic membrane
Internal auditory meatus
Cochlea
Canaliculus for tympanic nerve

FIG. 136.—Coronal Section of Right Temporal Bone passing through External and the Internal Auditory Meatuses.

The meatus and the lateral surface of the tympanic membrane should now be examined.

External Auditory Meatus.—The external meatus runs forwards and medially from its lateral orifice; and, during its course, it forms a slight curve with the convexity upwards. Its total length, measured from the bottom of the concha to the tympanic membrane, is 24 mm., of which 8 mm. corresponds with its cartilaginous part, and 16 mm. with its bony part; but, as the tympanic membrane is placed obliquely, the anterior wall and the floor are longer than the posterior wall and the roof. Moreover, the diameter of the canal is not uniform. Its narrowest point is called the *isthmus*, and is about 5 mm. from the tympanic membrane; the vertical diameter is greatest at the lateral end, whilst the antero-posterior diameter is greatest at its medial end. These facts must be borne in mind during the removal of foreign bodies from the canal. As the meatus passes medially, it describes a gentle sigmoid curve, but its general direction is towards the median plane with a slight inclination forwards.

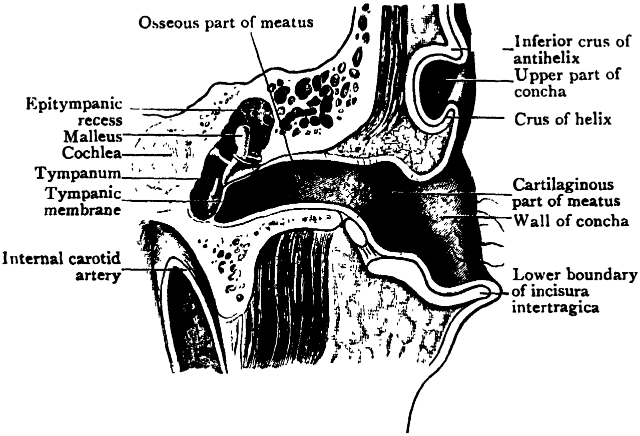


FIG. 137.—Coronal Section through Right Ear.
Anterior half of section viewed from behind. (Howden)

The skin that lines the cartilaginous portion is abundantly furnished with *ceruminous glands*, and is provided also with hairs which are directed laterally and hamper the entrance of small foreign bodies. The cutaneous lining of the osseous part is thin and tightly adherent to the periosteum, is destitute of hairs, has few glands or none, and is continued, as a very delicate layer, over the lateral surface of the tympanic membrane.

When the direction, the length, and the diameters of the external meatus have been noted, the dissectors should examine the lateral surface of the tympanic membrane.

The obliquity of the *tympanic membrane* has already been referred to. It slopes very obliquely downwards, forwards and medially, and its lateral surface is deeply concave. The medial surface is correspondingly convex, and the maximum point of the convexity is called the *umbo*. The lower end of a bar of bone, called the *handle of the malleus*, reaches the umbo. The handle is embedded in the membrane and can be seen through the thin layer of tissue that covers it. It extends upwards and slightly backwards from the umbo towards the roof of the meatus ; and near the upper margin of the membrane it becomes continuous with a small prominence, called the *lateral process of the malleus*, which bulges the membrane towards the meatus. The small portion of the membrane above the lateral process is less tense than the remainder, and is called the *flaccid part*. The whole of the peripheral margin of the membrane, except the flaccid part, is lodged in the *tympanic groove*, which is a ring-like sulcus in the tympanic element of the temporal bone.

Dissection.—**Secure the *tensor tympani* between the apex of the petrous temporal bone and the cartilaginous part of the pharyngo-tympanic tube. Trace it to the point where it passes into the bony canal that conducts it to the tympanum. Then, cut away the antero-lateral wall of the cartilaginous part of the tube, and pass a probe through the bony part of the tube into the tympanum.**

Turn next to the anterior surface of the petrous temporal, and, with chisel and bone forceps, carefully remove the tegmen tympani and expose the tympanic cavity from above. Carry the dissection forwards into the canal for the tensor tympani and backwards into the *tympanic antrum*. As the dissection is carried forwards, leave a narrow margin of bone along the anterior border of the tympanic membrane, and take care to avoid injury to the tendon of the tensor tympani, which emerges from its bony canal near the medial wall of the tympanum.

Preserve the *chorda tympani nerve*, which passes forwards close to the tympanic membrane.

MIDDLE EAR, TYMPANIC ANTRUM AND PHARYNGO-TYMPANIC TUBE

Middle Ear.—This narrow chamber is known also as the *tympanum* and the space within it is the *tympanic cavity*. It is lined with mucous membrane, and is filled with air. It communicates, anteriorly, with the pharynx through the pharyngo-tympanic tube, and, posteriorly, with small cavities in the temporal bone called the tympanic antrum and the mastoid air-cells.

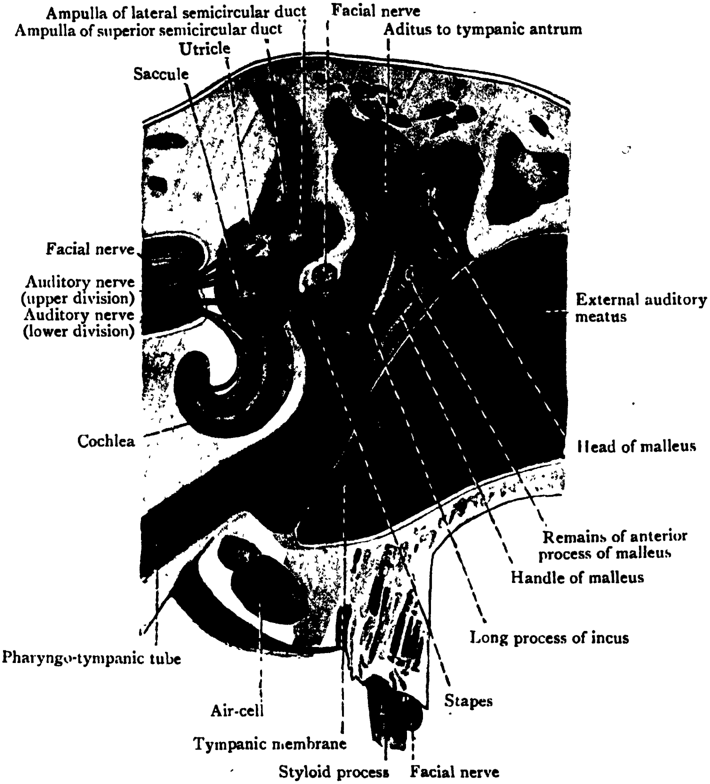


FIG. 138.—Tympanic Cavity and adjacent parts (semi-diagrammatic).

Besides air, the middle ear contains :—(1) small ossicles called the malleus, the incus and the stapes ; (2) two muscles—the stapedius and the tensor tympani ; (3) the tympanic plexus of nerves (p. 235) and the chorda tympani nerve.

The vertical and antero-posterior diameters of the cavity are each about 15 mm. Its width, from side to side, is only about 6 mm. above and 4 mm. below, and is still less in the centre because its lateral and medial walls both bulge into the cavity.

The part of the cavity above the level of the tympanic membrane is called the *epitympanic recess* (Figs. 135, 137).

The tympanic cavity has a roof and a floor, and four walls, viz., anterior, posterior, lateral and medial.

The **roof** is a thin plate of bone, termed the *tegmen tympani*, which separates the cavity from the middle cranial fossa. In chronic inflammatory conditions of the middle ear, an extension of the inflammatory process through the tegmen to the meninges of the brain is always to be feared.

The **floor** is narrow. It is a thin osseous lamina interposed between the tympanum and the jugular fossa, which is occupied by the upper bulb of the internal jugular vein; and an extension of an inflammatory condition of the middle ear through the bone to the vein may lead to thrombosis (clotting).

The **posterior wall** presents:—(1) in its upper part, the opening or *aditus* which leads from the epitympanic recess into the tympanic antrum; (2) lower down, close to the medial wall, a small, hollow, conical projection termed the *pyramid* (Fig. 139); and (3) lateral to the pyramid, the opening through which the chorda tympani nerve enters the tympanum. The pyramid is perforated on its summit, and the aperture leads into a canal which curves backwards and then downwards until it opens into the lower part of the canal for the facial nerve. The curved canal of the pyramid lodges the stapedius muscle, the delicate tendon of which enters the tympanic cavity through the aperture on the summit of the pyramid.

The **anterior wall** is narrow, because the medial and lateral walls converge anteriorly. Its upper part is occupied by the opening of the tensor tympani canal; its middle part by the orifice of the pharyngo-tympanic tube; and the lowest part is a lamina of bone which separates the tympanic cavity from the carotid canal (this lamina is sometimes described as part of the floor). The septum between the tube and the tensor tympani canal is prolonged backwards along the medial wall of the cavity as a shelf called the *processus cochleariformis*, and its end is moulded to form a pulley round which the tendon of the tensor tympani muscle turns abruptly in a lateral direction towards the malleus.

The **medial wall** intervenes between the middle ear and the internal ear. On it, there are eminences, depressions and apertures which require notice.

The anterior and larger part of the wall bulges into the cavity (Figs. 138, 139), and forms a very evident elevation termed the *promontory*. Above the posterior part of the promontory there is a depression leading to an oval aperture called the *fenestra vestibuli* (Fig. 139). In the macerated bone, the fenestra opens into the vestibule of the internal ear; but, in the recent state, it is closed by the footpiece of the stapes—the most medial of the auditory ossicles (Fig. 138). The pyramid, on the posterior wall, is immediately behind the fenestra vestibuli. Above the fenestra vestibuli, near the roof, there is an antero-posterior ridge produced by the canal for the facial nerve bulging into the tympanum (Fig. 139). The wall of the canal is so thin that the facial nerve can be seen in it. Below and behind the promontory, there is a small, round hole called the *fenestra cochleæ*. In the macerated bone, the fenestra leads into the cavity of the cochlea of the internal ear; but, in the recent state, it is closed by a membrane called the ***secondary tympanic membrane.***

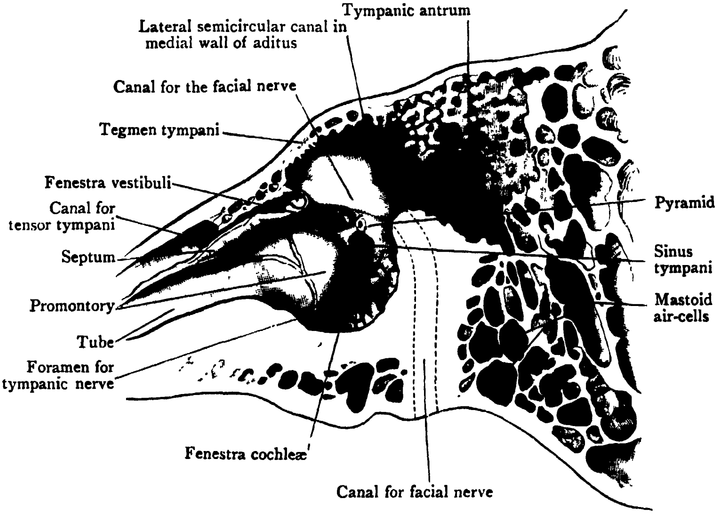


FIG. 139.—Vertical Section through Left Ear: postero-medial half of section viewed from the front. (Howden)

The *lateral wall* of the tympanic cavity is formed, for the most part, by the tympanic membrane, but, above the membrane, the lateral wall of the epitympanic recess is formed by the squamous part of the temporal bone (Figs. 137, 140).

Tympanic Membrane.—This is an elliptical disc stretched across the medial end of the external auditory meatus, and it forms the greater part of the lateral wall of the tympanum.

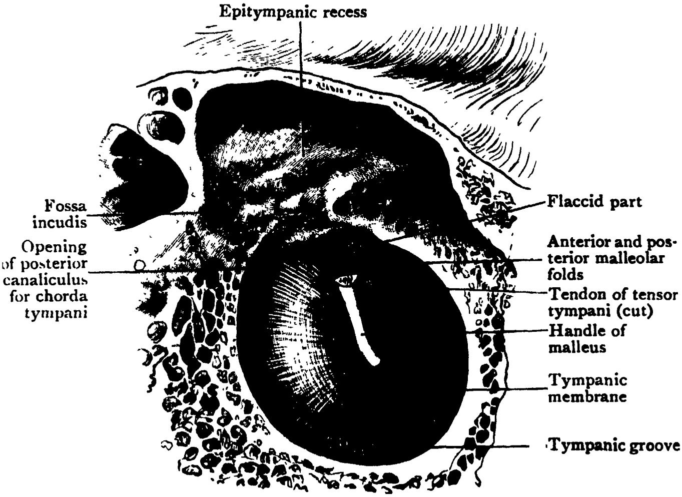

Epitympanic recess
Fossa incudis
Opening of posterior canaliculus for chorda tympani
Flaccid part
Anterior and posterior malleolar folds
Tendon of tensor tympani (cut)
Handle of malleus
Tympanic membrane
Tympanic groove

FIG. 140.—Left Tympanic Membrane and Epitympanic Recess viewed from within. The neck and head of the malleus have been removed to show the flaccid part of the membrane. (Howden)

It is placed very obliquely—looking downwards and forwards as well as sidewards.

The membrane is composed of three layers: a cuticular layer laterally, a mucous layer medially, and a fibrous lamina between them. The handle of the malleus is intimately connected with the fibrous layer, and is covered medially with the mucous layer. It draws the membrane medially and is the cause of the concavity of the lateral surface.

The mode of attachment of the membrane deserves some attention. At the medial end of the meatus, a ring-like ridge of bone, very distinctly grooved, forms a frame in which the membrane is set (Fig. 140). But the ridge is deficient above, and is replaced by a shallow depression called the *tympanic* *notch*; the floor of the notch gives attachment to the *flaccid part* of the membrane, which, owing to the absence of the fibrous layer, is less dense in its texture than the rest of the membrane as well as less tense. The edge of the part of the membrane which is fixed in the tympanic groove is thickened, and at the tympanic notch the thickened part is carried down to the lateral process of the malleus, forming the anterior and posterior boundaries of the flaccid part, and raising up slight ridges of the mucous membrane called the *anterior* and *posterior malleolar folds*.

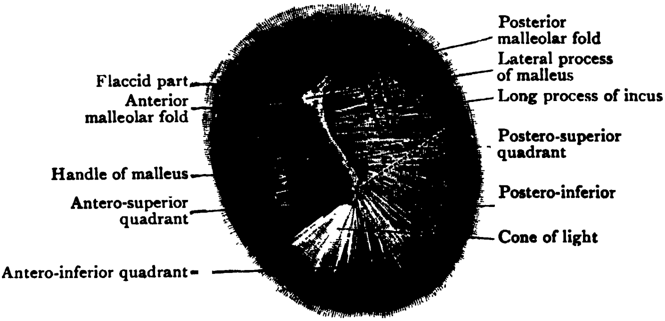


FIG. 141.—Left Tympanic Membrane as viewed from the external meatus during an otoscopic examination. The dotted lines indicate the four areas or quadrants into which the membrane is arbitrarily divided. (Howden)

When the living ear is examined with a speculum, the surface of the membrane appears highly polished, and a *cone of light* extends downwards and forwards from the tip of the handle of the malleus. A pair of striæ, which correspond to the anterior and posterior malleolar folds, extend from the lateral process of the malleus to the margins of the tympanic notch, and thus map out the flaccid part. The long process of the incus can be dimly seen through the tympanic membrane, parallel with and behind the handle of the malleus.

Tympanic Mucous Membrane.—The mucous lining is thin and delicate, but the chamber is so narrow that it may be choked when the membrane swells during inflammation. The membrane lines the walls and is reflected on to the bones and tendons to clothe them. It is continuous with the lining of the pharyngo-tympanic tube and with the lining of the tympanic antrum and mastoid air-cells.

Tympanic Antrum.—The tympanic antrum is an air-chamber in the temporal bone. It lies immediately behind the epitympanic recess, with which it communicates through a relatively wide opening called the *aditus ad antrum* ; and, in the adult, it is 15 mm. (a little more than half an inch) medial to the floor of the suprameatal triangle. In the child, it is much more superficial.

The cavity of the antrum is lined with mucous membrane which is continuous, anteriorly, through the aditus, with the mucous membrane of the tympanic cavity, and, posteriorly and below, with the mucous membrane of the mastoid air-cells.

The *roof* of the tympanic antrum is the *tegmen tympani*. It separates the tympanic antrum from the middle cranial fossa and from the membranes that cover the inferior surface of the temporal lobe. The *lateral wall* is formed by that portion of the squamous temporal bone which lies immediately above and behind the external auditory meatus. The *posterior wall* and the *floor* are formed by the mastoid portion of the temporal bone, and it is through apertures in those boundaries that the cavity of the tympanic antrum communicates with the mastoid air-cells. The *medial wall* is formed by the petrous part of the temporal bone, and on it there is a horizontal bulging caused by the lateral semicircular canal of the internal ear; the bulging extends forwards into the aditus (Figs. 138, 139). As the canal for the facial nerve passes from the medial wall of the middle ear to the posterior wall it traverses the lower boundary of the aditus (Fig. 139). The sigmoid sinus is behind the antrum, and the upper bulb of the internal jugular vein is below it; if the sigmoid groove and jugular fossa are deep, as they often are on the right half of the skull, the bone is so thinned down that these vessels are dangerously near an inflamed antrum.

The antero-posterior diameter of the tympanic antrum is about 14 mm., the vertical diameter about 9 mm., and the transverse diameter about 7 mm.

Auditory Ossicles.—These little bones are named the malleus, the incus and the stapes. They extend in a chain from the lateral wall of the tympanum to the medial wall—the malleus being fixed to the lateral wall, the stapes to the medial wall, and the incus slung between them. The main parts of the **malleus** are a rounded upper part, called its *head*, which lies in the epitympanic recess, and a slender *handle*, which is attached to the tympanic membrane. The *body* of the **incus** lies in the epitympanic recess, and articulates with the head of the malleus. It sends downwards a *long process* which articulates with the head of the stapes. The **stapes** is shaped like a stirrup; its foot-piece is called its *base*, and fits into the fenestra vestibuli on the medial wall of the tympanum.

The detailed description of these ossicles and their connexions is given in the large text-books of Anatomy.

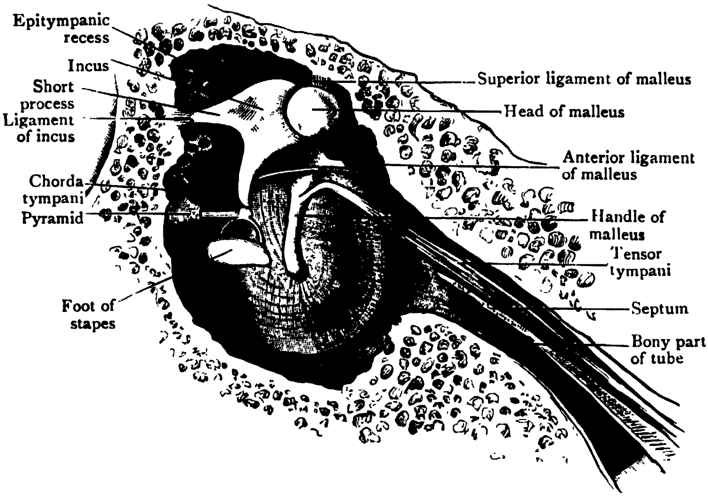


FIG. 142.—Left Tympanic Membrane and Chain of Auditory Ossicles seen from the medial side. The figure shows also the pharyngo-tympanic tube, the tensor tympani, the tendon of the stapedius and the chorda tympani nerve. (Howden)

Tympanic Muscles.—Two tiny muscles end in the tympanic cavity, viz., the stapedius and the tensor tympani.

The **stapedius** occupies the interior of the pyramid and the canal which curves downwards from it. Its tendon enters the cavity through the aperture on the summit of the pyramid, and is inserted into the back of the neck of the stapes. It is supplied by a branch from the *facial nerve*. Its function is not fully understood.

The **tensor tympani** arises from the upper part of the cartilage of the pharyngo-tympanic tube and from the contiguous parts of the greater wing of the sphenoid and the petrous part of the temporal bone. From its origin it passes backwards and laterally through a canal above the osseous part of the tube. In the tympanic cavity the tendon turns at right angles, round the end of the processus cochleariformis (p. 343), and passes laterally to its insertion into the upper part of the handle of the malleus. The tensor tympani is supplied through the *otic ganglion* from the mandibular nerve. Its action is implied in its name.

Chorda Tympani Nerve.—The chorda tympani is a branch of the facial nerve; it is distributed to the mucous membrane of the anterior two-thirds of the tongue and is the chief nerve of taste. It arises in the canal for the facial nerve a short distance above the stylo-mastoid foramen, and ascends to enter a narrow tunnel which conducts it to the posterior wall of the middle ear, lateral to the pyramid. The nerve then passes forwards, outside the mucous membrane, opposite the upper margin of the tympanic membrane, across the medial side of the neck of the malleus, to reach the uppermost part of the anterior wall of the tympanum. There, it enters another canaliculus which conducts it along the lateral wall of the pharyngo-tympanic tube to the base of the skull at the medial end of the squamo-tympanic fissure. From that point it runs downwards and forwards, grooving the medial side of the spine of the sphenoid, and joins the lingual nerve a little below the skull; and the lingual nerve carries it to the tongue.

Pharyngo-Tympanic Tube (Tuba Auditiva).—This tube is divided into an osseous and a cartilaginous portion. The *cartilaginous part* is about an inch in length, and is described on p. 292.

The *bony part* is about half an inch in length. It is widest at its entrance into the tympanic cavity, and narrowest at its other end, which appears on the base of the skull behind and medial to the spine of the sphenoid. The bony part lies between the tympanic plate and the petrous temporal, below the canal for the tensor tympani muscle. The internal carotid artery, in the carotid canal, is medial to it; the chorda tympani nerve is lateral to it; and the upper part of the mandibular joint is an antero-lateral relation.

Dissection.—**Second Method. On the opposite temporal bone, approach the bony part of the external meatus, the tympanic antrum, and the tympanic cavity from the postero-lateral aspect. Carry out the dissection after the manner adopted by**

the surgeon when operating for the cure of extensive mastoid and middle ear disease ; but, to gain better access to the bone, remove the auricle by cutting through the cartilaginous part of the external meatus.

Take all the soft parts, including the periosteum, from the lateral surface of the mastoid temporal bone, and identify : (1) the suprameatal triangle, and (2) the supramastoid crest.

The object of the first stage of the dissection is the exposure of the mastoid air-cells and the tympanic antrum, without injury to the bony part of the external meatus and to the sigmoid sinus.

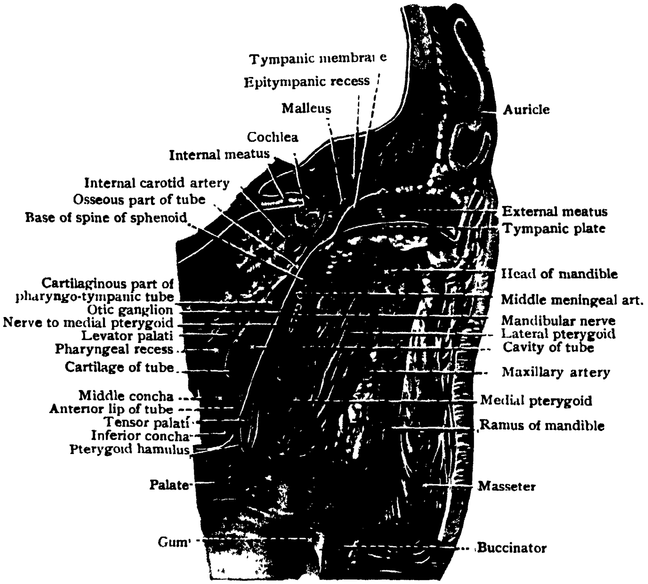


FIG. 143.—Oblique Section of a part of Head showing the Relations of the Pharyngo-Tympanic Tube.

The tympanic antrum is about half an inch medial to the floor of the suprameatal triangle. Begin the dissection in the suprameatal triangle, and carry it forwards and medially into the bone parallel with the posterior wall of the external meatus, until the antrum is opened. After the antrum has been identified, remove the spongy tissue of the anterior part of the mastoid area gradually till the more medially situated compact bone is exposed.

When that stage of the dissection is completed, the dissector should note the following points:—(1) In the anterior boundary of the exposed area, there is the compact posterior wall of the bony part of the ***external meatus.*** (2) Posteriorly, there is a broad projecting ridge indicating the position of the groove which lodges the *sigmoid sinus*. (3) At the upper and deeper part of the area, there are the medial wall of the *tympanic antrum* and the *aditus*. (4) The intervening area is occupied by the remains of the *mastoid air-cells*, which are continuous above with the tympanic antrum and may extend downwards to the tip of the mastoid process. (5) On the medial wall of the aditus and the anterior part of the medial wall of the antrum, there is an oblique elevation produced by the *lateral*

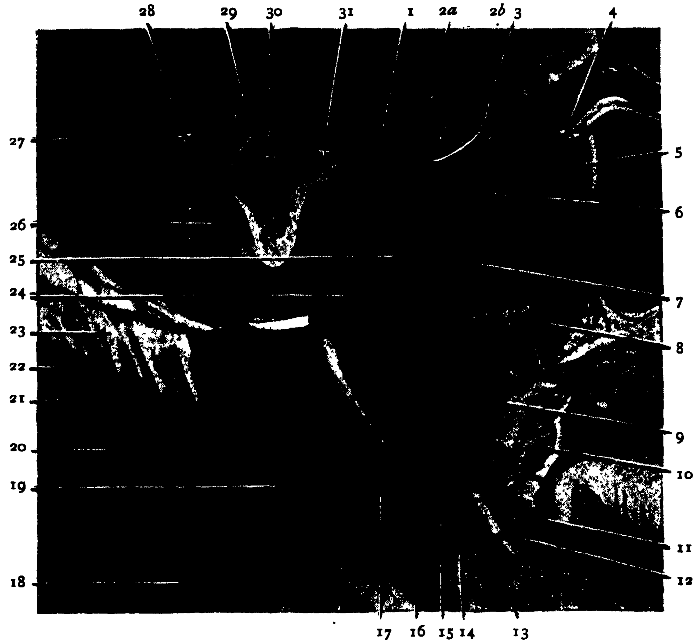


FIG. 144.—Region of Pharyngo-Tympanic Tube and Tympanic Antrum (see Figs. 54, 104).

1. Middle meningeal artery in the foramen spinosum.
2a, 2b. Posterior and anterior branches of middle meningeal artery.
3. Mandibular nerve.
4. Maxillary nerve.
5. Maxillary artery.
6. Upper part of tensor palati muscle.
7. Cavity of pharyngo-tympanic tube.
8. Lower part of tensor palati muscle.
9. Superior constrictor muscle.
o. Buccinator muscle.
1. Mucous membrane of mouth.
2. Lingual nerve.
3. Submandibular gland.
4. Ascending palatine artery.
5. Stylo-glossus muscle.
16. Stylo-hyoid muscle.
17. External carotid artery.
18. Levator scapulæ and scalenus medius.
19. Posterior belly of digastric muscle.
20. Longissimus capitis muscle.
21. Occipital artery.
22. Splenius capitis muscle.
23. Sterno-mastoid muscle.
24. Internal carotid artery.
25. Levator palati muscle.
26. Facial nerve.
27. Sigmoid sinus.
28. Tympanic antrum.
29. Malleus and incus.
30. Tympanic membrane.
31. Bony part of pharyngo-tympanic tube.

semicircular canal, and, below it, in the posterior wall of the tympanum, there is a vertical ridge that indicates the position of the *facial nerve* (Figs. 139, 146).

The next stage is the removal of the posterior wall of the external meatus and the exposure of the lateral surface of the tympanic membrane.

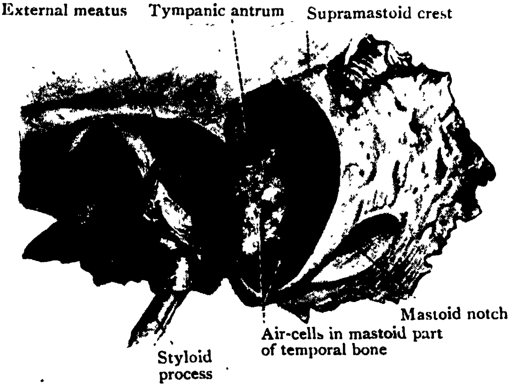


FIG. 145.—Dissection of Tympanic Antrum and Mastoid Part of Temporal Bone.

Dissection.—After the tympanic membrane has been examined, pass a seeker through the aditus into the tympanic cavity, and allow its handle to rest on the lower part of the exposed area ; then, whilst the seeker remains in position, cut away the remainder of the posterior wall and the upper boundary

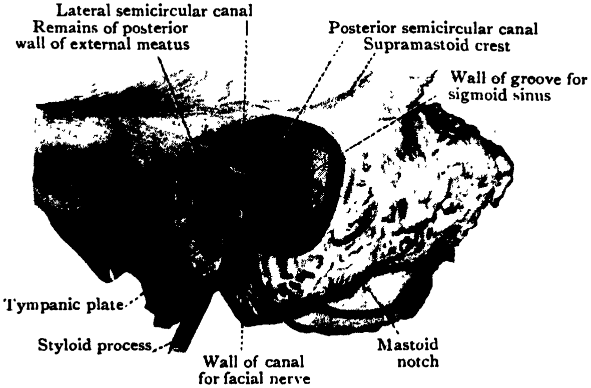

Lateral semicircular canal
Remains of posterior wall of external meatus
Posterior semicircular canal
Supramastoid crest
Wall of groove for sigmoid sinus
Tympanic plate
Styloid process
Wall of canal for facial nerve
Mastoid notch

FIG. 146.—Dissection of Tympanic Antrum and Petro-Mastoid Part of Temporal Bone from the lateral side. The arrow passes through the aditus from the tympanic antrum into the tympanic cavity.

of the external meatus, from the level of the seeker to the level of the roof of the tympanic antrum. Complete the dissection by removing the tympanic membrane and ossicles.

A complete view is now obtained of the medial walls of the tympanic cavity and antrum and the aditus. Anteriorly, on the medial wall of the tympanic cavity, the *promontory* marks the position of the first turn of the cochlea. Above and behind the promontory, the *fenestra vestibuli* is seen. The *fenestra cochleæ* is at the lower and posterior part of the promontory. Above the fenestra vestibuli, there is a ridge caused by the posterior horizontal part of the *canal for the facial nerve*; this becomes continuous, on the lower wall of the aditus, with the ridge which indicates the vertical part of the canal. Above that, there is the elevation due to the *lateral semicircular canal.*

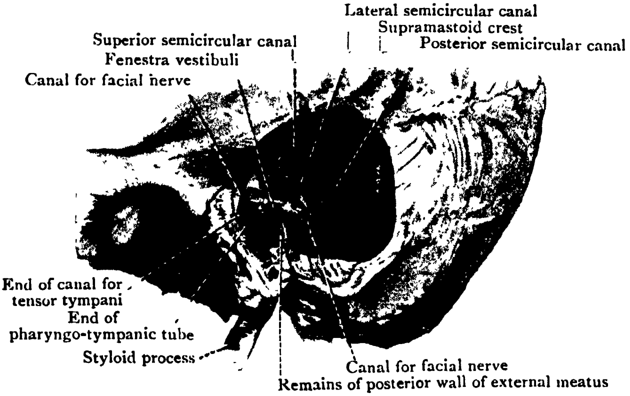

Lateral semicircular canal
Supramastoid crest
Superior semicircular canal
Posterior semicircular canal
Fenestra vestibuli
Canal for facial nerve
End of canal for tensor tympani
End of pharyngo-tympanic tube
Styloid process
Canal for facial nerve
Remains of posterior wall of external meatus

FIG. 147.—Dissection of Tympanic Cavity and Semicircular Canals from the lateral side.

***Dissection.*—Open the canal for the facial nerve in order to expose the facial nerve. Then, open the lateral semicircular canal, and afterwards remove the bone above and behind it to expose the walls of the superior and posterior semicircular canals (Figs. 145-147).**

INTRAPETROUS PARTS OF FACIAL AND AUDITORY NERVES

The facial and auditory nerves have already been traced into the internal meatus (p. 122). The dissectors should now open up the meatus and follow the facial nerve in its course through the petrous portion of the temporal bone. The canal which it occupies begins at the bottom of the internal meatus, and opens on the exterior of the skull at the stylo-mastoid foramen. Between its commencement and termination it pursues a devious course, and that, combined with the density of the bone, makes the dissection difficult.

Complete the dissection to expose the facial nerve and examine the auditory nerve on the side on which the middle ear has been opened from the lateral side, and the canal for the facial nerve has already been partially opened up.

Dissection.—**Separate the temporal bone from the other cranial bones which still adhere to it, and fix it in the natural position (in a vice if possible). Remove the squamous portion by a horizontal saw-cut at the level of the anterior surface of the petrous portion. Make a second horizontal saw-cut, immediately above the roof of the internal meatus, and carry it laterally into the tympanum, in which it should emerge immediately above the canal for the facial nerve where that canal lies above the fenestra vestibuli. Then, with the bone-forceps or chisel, remove the remains of the roof of the internal meatus and follow the facial nerve along the canal till it begins to bend backwards, and so expose its ganglion, which lies on that bend. Secure the branches which arise from the ganglion, and then follow the nerve backwards above the fenestra vestibuli. The greater part of the vertical portion of the canal has already been opened from the lateral side; the remainder can now be displayed by means of two saw-cuts:—(1) a vertical transverse section carried medially from the lateral surface of the bone to the posterior border of the stylo-mastoid foramen; (2) a sagittal cut carried from the posterior surface of the bone to meet cut (1). Remove the portion of bone between the two cuts, and complete the dissection with bone-forceps.**

Intrapetrous Portion of Facial Nerve.—As the nerve traverses the petrous bone, it may be divided into four parts which differ in their direction and relations. They are:—

1. A part within the internal auditory meatus.
2. A very short part between the meatus and the ganglion.
3. A part in the upper part of the medial wall of tympanum.
4. A part which descends to the stylo-mastoid foramen.

First Part.—In the internal meatus, the facial nerve runs almost directly laterally in company with the auditory nerve. In that stage of its course it lies in relation to the upper and anterior part of the auditory nerve, and its motor and sensory roots join each other. At the bottom of the meatus, it enters the canal which conducts it through the bone.

Second Part.—The second part of the facial nerve is very short. It runs laterally, with a slight inclination forwards, above the vestibule of the internal ear, and very soon ends in the swelling termed its *ganglion.*

Third Part.—At the ganglion, the facial nerve bends suddenly; it then proceeds backwards and slightly downwards in that portion of the canal which runs in the upper part of the medial wall of the tympanic cavity immediately above the fenestra vestibuli.

Fourth Part.—The fourth part is vertical, and passes downwards behind the middle ear to gain the stylo-mastoid foramen (Figs. 54, 144).

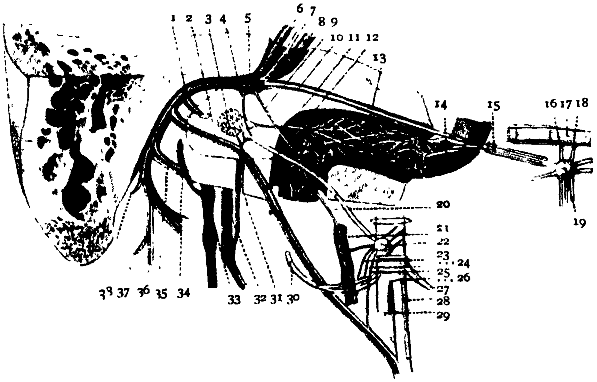


FIG. 148.—Diagram of Intrapetrous Part of Facial Nerve and its Connexions. (A. M. Paterson.)

1. Nerve to stapedius.
2. Chorda tympani.
3. Tympanic plexus.
4. Root of lesser superficial petrosal.
5. Ganglion of facial nerve.
6. Motor root of facial nerve.
7. Sensory root of facial nerve.
8. Auditory nerve.
9. External petrosal nerve.
10. Greater superficial petrosal nerve.
11. Carotid canal.
12. Carotico-tympanic branch.
13. Carotid plexus.
14. Great deep petrosal.
15. Nerve of pterygoid canal.
16 and 18. Ganglionic branches.
17. Maxillary nerve.
19. Spheno-palatine ganglion.
20. External petrosal nerve.
21. Middle meningeal artery.
22. Otic ganglion.
23 and 24. Branches to auriculo-temporal nerve.
25. Communication to chorda tympani.
26. Posterior division } of mandibular
27. Anterior division } nerve.
28. Lingual nerve.
29. Inferior dental nerve.
30. Auriculo-temporal nerve.
31. Tympanic nerve.
32. Glosso-pharyngeal nerve.
33. Vagus.
34. Auricular branch of vagus.
35. Communication from facial to auricular branch of vagus.
36. Nerve to digastric (post. belly).
37. Nerve to stylo-hyoid muscle.
38. Posterior auricular nerve.

The *branches* which spring from or join the facial nerve during its passage through the temporal bone are :—

1. The greater superficial petrosal nerve (p. 120), } from the ganglion.
2. A root of the lesser superficial petrosal (p. 120), } from the ganglion.
3. External petrosal nerve (p. 120), } from the ganglion.
4. Nerve to stapedius.
5. Chorda tympani (p. 349).
6. Communicating twigs to the auricular branch of vagus.

The *nerve to the stapedius muscle* arises from the facial as it passes downwards behind the pyramid. It enters the base of the pyramid and thus reaches the stapedius muscle.

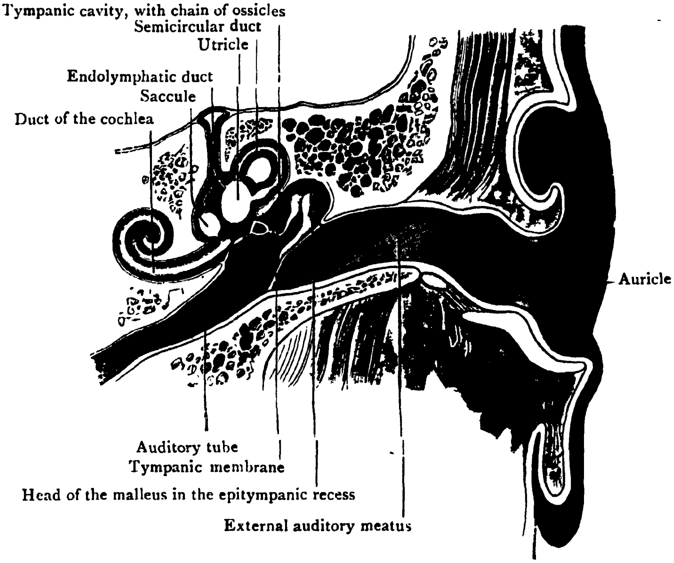


FIG. 149.—Diagrammatic View of the Parts of the Ear.

The *communicating twigs to the auricular branch* of the vagus arise a short distance above the stylo-mastoid foramen.

Auditory Nerve.—In the internal meatus, the auditory nerve lies at a lower level than the facial. At the bottom of the meatus, it splits into its two constituent nerves—*cochlear* and *vestibular*—which subdivide further and pass through the foramina in the bottom of the meatus to supply the different parts of the labyrinth of the internal ear (Fig. 138).

INTERNAL EAR

The internal ear consists of an intricate system of cavities enclosed in very dense bone, called the *bony labyrinth*, in the petrous part of the temporal bone, and a series of hollow membranous structures which lie in the bony labyrinth and constitute the *membranous labyrinth*. The membranous labyrinth does not lie in close contact with the walls of the bony labyrinth; the space between them is occupied by a clear liquid called *perilymph*, and the membranous labyrinth itself is filled with a clear liquid called *endolymph*.

Dissection.—**To expose the labyrinth of the internal ear, make two saw-cuts: (1) an antero-posterior vertical cut, carried from the upper surface of the bone downwards to the floor of the tympanum, along the junction of its medial and posterior boundaries; (2) a horizontal cut. Begin the horizontal cut at the apex of the petrous temporal and carry it laterally till it joins the vertical cut, posteriorly, and enters the tympanic cavity anteriorly at the level of the mid-height of the promontory. When the bone separated by the two cuts is removed, the vestibular and cochlear parts of the labyrinth and portions of the semicircular canals will be displayed. Demonstrate the positions and curves of the semicircular canals and the canal for the facial nerve by passing bristles through them.**

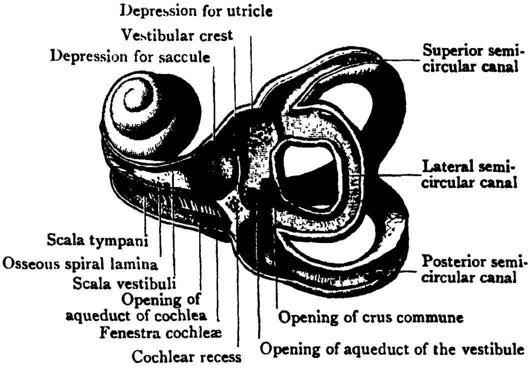


FIG. 150.—Interior of Left Bony Labyrinth viewed from the lateral aspect. (Howden.)

When the dissectors have acquired a knowledge of the position of the cochlea and semicircular canals, they will find it both instructive and interesting to display them in a dry bone —using a fine chisel for the purpose.

The bony labyrinth is divided into three parts :—(1) a small chamber called the *vestibule* ; (2) a coiled tube, called the *cochlea*, in front of the vestibule; (3) three *semicircular canals*, behind the vestibule. The cochlea and the canals communicate freely with the vestibule; and all the parts have a delicate lining of endosteum.

Vestibule.—The vestibule is a small ovoid bony chamber, about 5 mm. in length, placed between the medial wall of the tympanum and the bottom of the internal auditory meatus. The three semicircular canals open into its posterior part by *five round apertures* ; whilst, in its lower and anterior part, there is the opening of one of the subdivisions of the cochlea called the *scala vestibuli*.

On the *lateral wall*, there is the *fenestra vestibuli*, which is closed, in the recent state, by the endosteal lining and by the base of the stapes. When these parts are removed, the vestibule communicates directly with the tympanum. A small aperture in the posterior part of the medial wall also deserves mention. It is the mouth of the *aqueduct of the vestibule*—a small canal which passes backwards to the posterior surface of the petrous part of the temporal bone, where it opens under the dura mater.

Semicircular Canals.—Each of the three semicircular canals forms considerably more than half a circle ; and they occupy planes at right angles to one another, like three faces of a cube. They are termed superior, posterior and lateral, and they open into the posterior part of the vestibule by five round orifices ; the number of openings is reduced to five because the adjoining ends of the superior and posterior canals are fused into a common canal.

The **superior semicircular canal** forms the uppermost part of the labyrinth. Its highest part lies beneath the arcuate eminence on the anterior surface of the petrous part of the temporal bone. It is placed vertically, and is almost transverse to the long axis of the petrous part of the temporal bone. The **posterior semicircular canal** is the longest of the three tubes, and it also is vertical; it lies in a plane parallel to the posterior surface of the petrous temporal. The **lateral semicircular canal** is the shortest of the tubes ; it lies in a horizontal plane in the angle between the superior and posterior canals, and it makes a bulge on the medial wall of the aditus ad antrum.

Cochlea.—The cochlea is a tapering tube coiled spirally, for two and a half turns, around a central pillar termed the *modiolus.* The appearance produced is like that of a spiral shell laid on its side. The cochlea is in front of the vestibule; its base is directed towards the bottom of the internal meatus; its long axis runs forwards and laterally from the base; and its apex lies in close relation with the canal for the tensor tympani muscle.

The cochlear tube rapidly diminishes in diameter as it is traced towards the apex of the cochlea; the first turn which it takes around the modiolus produces the bulging called the promontory on the medial wall of the tympanum (Figs. 139, 151).

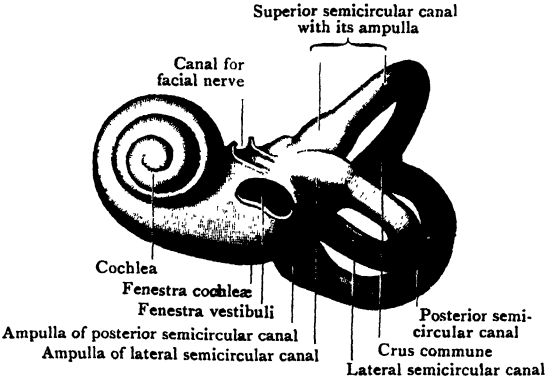

Superior semicircular canal with its ampulla
Canal for facial nerve
Cochlea
Fenestra cochleæ
Fenestra vestibuli
Ampulla of posterior semicircular canal
Ampulla of lateral semicircular canal
Posterior semicircular canal
Crus commune
Lateral semicircular canal

FIG. 151.—Left Bony Labyrinth viewed from lateral side. (Howden.)

The *modiolus* is thick at the base, but rapidly tapers towards the apex. Its base abuts against the bottom of the internal meatus. It forms the inner wall of the cochlear tube; and winding spirally round it, like the thread of a screw, there is a thin lamina of bone, termed the *spiral lamina,* which partially subdivides the cochlear tube into two canals.

Numerous minute canals traverse the modiolus, and one more conspicuous than the others runs lengthwise in its centre. The spiral lamina also is tunnelled by small canals in communication with those in the modiolus, whilst one—the *spiral canal of the modiolus*—winds spirally around the modiolus in the attached margin of the spiral lamina. All these channels convey filaments from the cochlear nerve to the duct of the cochlea; and the spiral canal lodges the *spiral ganglion,* which is the ganglion of the cochlear nerve.

The *duct of the cochlea* is a spiral membranous tube, and is the part of the membranous labyrinth that lies within the bony cochlea. It is placed between the spiral lamina and the opposite side of the wall of the cochlear tube. With the spiral lamina, it divides the cochlea into two canals termed the scala tympani and the scala vestibuli.

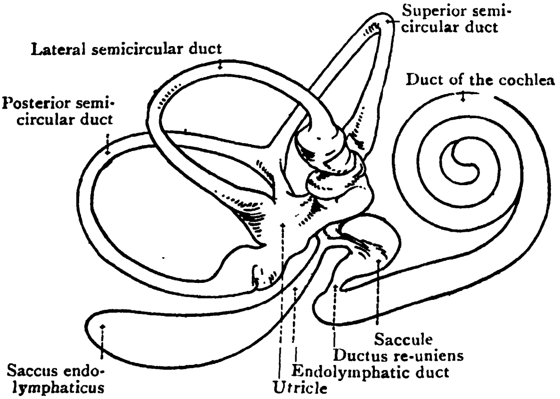


FIG. 152.—Diagrammatic representation of the different parts of Right Membranous Labyrinth.
(From a model by Dickie and Fraser.)

The *scala tympani* begins at the fenestra cochleæ, where the secondary tympanic membrane shuts it off from the tympanic cavity. At the apex of the cochlea it communicates with the scala vestibuli through an aperture termed the *helicotrema.* At the base of the cochlea the *scala vestibuli* communicates with the lower and anterior part of the vestibule. The perilymph in the semicircular canals and vestibule is therefore directly continuous with that in the two scalæ.

It can now be understood how vibrations of the tympanic membrane are communicated to the perilymph. The movements of the chain of ossicles affect the perilymph in the vestibule through the base of the stapes. The vibrations of the perilymph, passing along the scala vestibuli into the scala tympani, affect in turn the secondary tympanic membrane. With every inward movement of the tympanic membrane and of the base of the stapes, there is an outward movement of the secondary tympanic membrane, and *vice versa.* The vibrations of the perilymph affect the endolymph in the membranous labyrinth, and thus excite the terminations of the auditory nerve.

Membranous Labyrinth.—The chief parts of the membranous labyrinth are :—(1) The duct of the cochlea ; (2) two small membranous sacs, called the utricle and the saccule, which lie in the vestibule ; and (3) three membranous tubes, called semicircular ducts, which lie in the semicircular canals (Figs. 149, 152).

The *semicircular ducts* are considerably narrower than the canals, and are attached to their outer walls. They open into the utricle.

The *utricle* occupies a depression on the upper wall of the vestibule. The *saccule* is smaller, and lies in a depression below and in front of the utricle. These two sacs communicate indirectly by means of a slender membranous tube called the *endolymphatic duct* ; this duct occupies the bony aqueduct of the vestibule and divides into two branches which separate to open into the utricle and the saccule. A short, narrow tube, called the *ductus re-uniens*, connects the saccule with the duct of the cochlea.

The *duct of the cochlea* lies between the two scalæ. Each of its ends is blind. The ductus re-uniens opens into it near its basal end.

EYEBALL

The eyeball or globe of the eye lies in the anterior part of the orbit amidst the orbital muscles and fat; they make a socket in which the eyeball rotates; and the socket is lined with the fascial sheath of the eyeball (p. 143).

The eyeball is about one inch in diameter, but is not perfectly spherical, for the anterior, clear part—the cornea—has a sharper curvature than the rest of the globe, and makes therefore a slight bulging on the front of the eyeball.

A satisfactory dissection of the globe of the eye can be made only when the eyeball is fresh, or after it has been hardened for several days in a 10 per cent. solution of formol. In the dissecting-room it is often impossible to obtain suitable specimens; but it is always easy to procure eyeballs of the pig, sheep, or ox; and these suit the purpose admirably. It is advisable, however, that the dissectors should complete their study of the organ by the examination of a fresh human eyeball obtained from the post-mortem room. In point of size, and also in other particulars, the eyeball of the pig more closely resembles the human eyeball than the eyeball of the sheep or ox. But it is better to begin with the eyeball of the ox, because the necessary dissection can be more easily carried out in it than in smaller eyeballs; and the students should provide themselves with six eyeballs from oxen. Begin work on them at once, and place them in preservative liquid when work is interrupted; but the one chosen for the study of the vitreous body (p. 372) should be laid aside for a day or two and allowed to lose its freshness before it is dissected.

Dissection.—Remove the conjunctiva, fascial sheath, orbital muscles and fat. With the forceps, pick up the conjunctiva and the fascial sheath close to the corneal margin, and snip through those layers with the scissors and divide them round the whole edge of the cornea. Then, strip all the soft parts from the surface of the sclera, working steadily backwards towards the entrance of the optic nerve. A little behind the equator of the eyeball the veins called _venæ vorticosæ_ will be noticed issuing from the sclera at wide intervals from one another; and, as the back of the eyeball is approached, the posterior ciliary arteries and the ciliary nerves will be seen piercing the sclera around the entrance of the optic nerve.

To obtain a general conception of the parts which compose the eyeball, make sections through three hardened specimens in three different planes. Divide one specimen at the equator and another into halves by a sagittal section. Divide the third horizontally and remove a portion of the jelly-like mass called the vitreous body (Fig. 153). Place the sections under water in a cork-lined tray, and preserve them for reference as the study of the eyeball is proceeded with.

General Structure of Eyeball.—The eyeball has three concentrically arranged coats, and they enclose a cavity which is filled with three of the four media that refract the rays of light.

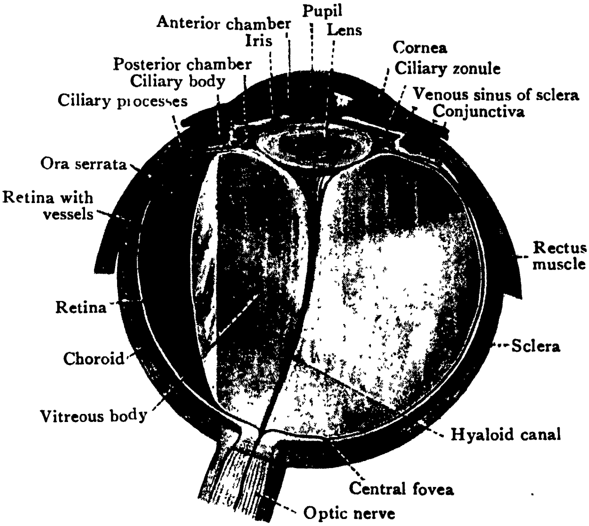


FIG. 153.—Diagrammatic Section of Eyeball.

The coats are :—(1) An external, fibrous envelope divided into (*a*) a posterior part called the *sclera*, which is white and opaque, and (*b*) an anterior part called the *cornea*, which is transparent. (2) A middle envelope which is vascular and muscular, and in which three subdivisions are recognised, viz., a posterior part called the *choroid*, an anterior portion termed the *iris*, which lies behind the cornea, and an intervening part called the *ciliary body*. (3) An internal, nervous coat called the *retina*, in which the fibres of the optic nerve are outspread.

The refracting media are:—(1) the cornea; (2) a watery liquid called the *aqueous humour*, which lies behind the cornea and is contained in a space partially subdivided by the iris into the *anterior* and *posterior chambers of the eye*; (3) the *lens*, behind the posterior chamber; and (4) the *vitreous body*, which occupies the posterior part of the interior of the eyeball.

The superficial surface of the sclera and of the cornea should now be examined; but, to complete the study of the external coat, a further dissection is required.

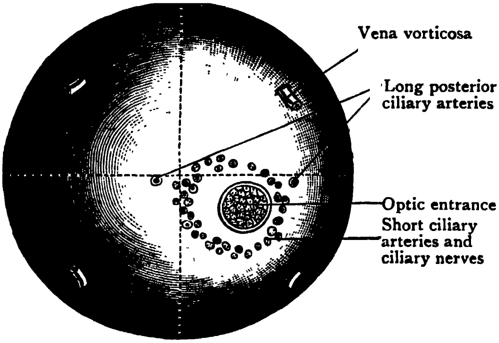

Vena vorticosa
Long posterior ciliary arteries
Optic entrance
Short ciliary arteries and ciliary nerves

FIG. 154.—Diagram of the Back of Left Eyeball. The excentric position of the entrance of the Optic Nerve is slightly exaggerated. (After Testut, modified.)

Dissection.—**Make an incision, with a sharp knife, through the sclera at the equator. Make the cut carefully, and the moment that the subjacent black choroid coat appears lay the knife aside. Seize the cut edge of the sclera with the forceps, and carry the incision completely round the eyeball, with the scissors, along the line of the equator. The outer fibrous coat is thus divided into an anterior and a posterior portion. Raise both parts from the subjacent structures. As the anterior portion is turned forwards, some resistance will be met with close to the margin of the cornea; it is due to the attachment of the ciliary muscle to the deep surface of the sclera. Break down the attachment with the closed points of blunt forceps; as soon as that is done the aqueous humour escapes. Complete the separation of the posterior part of the sclera by dividing the fibres of the optic nerve close to the point where they enter the sclera from the inner side.**

The eyeball, denuded of its external tunic, should now be placed in a shallow vessel filled with water.

Sclera.—The sclera is the white of the eye. It is a dense, resistant tunic, opaque-white in colour, which envelops the posterior five-sixths of the eyeball. The sclera is very loosely attached to the choroid by some pigmented, flocculent areolar tissue, but it is adherent to the ciliary body.

The point at which the optic nerve pierces the sclera does not correspond with the posterior pole of the eyeball, but is situated about 3 mm. to the medial or nasal side of the pole and 1 mm. below it. There, the bundles of optic nerve fibres pass through a number of small apertures and the sheath of the optic nerve, which is derived from the membranes of the brain, blends with the sclera.

The sclera is pierced also by numerous blood-vessels and nerves. The long and short posterior ciliary arteries, with the ciliary nerves, perforate the sclera around the optic nerve ; four or five venæ vorticosæ issue from the interior of the eyeball by piercing the sclera a short distance behind the equator, at wide intervals from one another ; and the anterior ciliary arteries pierce it near the corneal margin.

The sclera is directly continuous with the cornea, and close to their junction, a minute canal in the sclera, termed the *sinus venosus scleræ*, encircles the margin of the cornea.

Cornea.—The cornea is the transparent window through which the rays of light gain admittance into the eyeball. It forms the anterior sixth of the outer coat of the eyeball, and is separated from the iris by the aqueous humour in the anterior chamber of the eyeball.

The anterior surface of the cornea is clothed with a transparent epithelial layer which is continuous with the conjunctiva at the margin of the cornea. On its posterior surface there is an elastic, glassy stratum termed the *posterior elastic lamina*. When the cornea is relaxed that lamina becomes wrinkled, and it can be torn away in shreds from the proper corneal tissue.

Ligamentum Pectinatum Iridis.—At the margin of the cornea the posterior elastic lamina is fibrillar, and some of its fibres are continued into the iris, forming the *pectinate ligament of the iris*, whilst others are prolonged backwards into the choroid and the sclera. The pectinate ligament bridges across the angle between the cornea and the iris, and the bundles of fibres into which the posterior elastic lamina breaks up in that region constitute the boundaries of an annular, sponge-like series of minute spaces termed the *spaces of the irido-corneal angle*. The spaces communicate with the anterior chamber of the eyeball, and are filled with aqueous humour.

The three parts of the middle coat are exposed in the specimen from which the sclera and the cornea were removed.

Choroid.—The choroid is the largest part of the middle coat, and lies between the sclera and the retina. It is thickest posteriorly, where it is pierced by the optic nerve, and becomes thinner as it approaches the ciliary body. It is connected with the sclera by some lax, pigmented areolar tissue, and also by blood-vessels and nerves which pass from the one into the other. The deep surface of the choroid is moulded upon the retina and is in contact with a layer of deeply-pigmented cells which usually adheres to the choroid when that coat is removed, although, in reality, it is a portion of the retina.

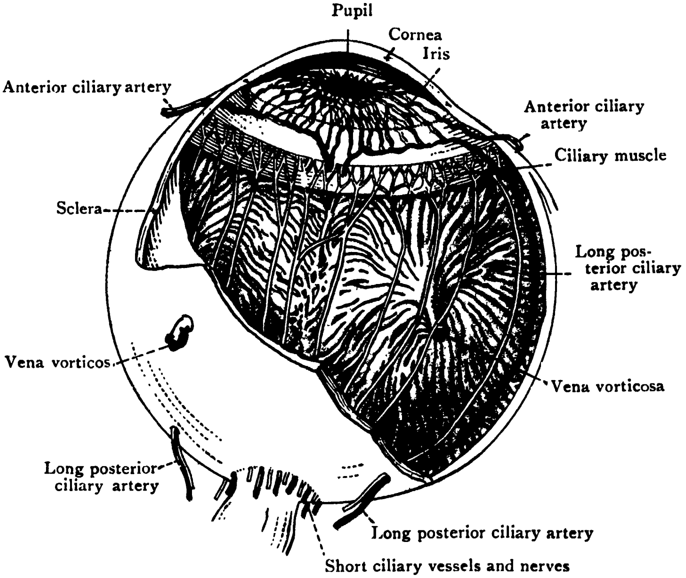

Pupil
Cornea
Iris
Anterior ciliary artery
Anterior ciliary artery
Ciliary muscle
Sclera
Long posterior ciliary artery
Vena vorticosa
Vena vorticosa
Long posterior ciliary artery
Long posterior ciliary artery
Short ciliary vessels and nerves

FIG. 155.—Dissection of Eyeball showing the Vascular Coat and arrangement of Ciliary Nerves and Vessels.

The choroid is composed chiefly of blood-vessels. They are arranged in two well-marked layers, viz., a deep, closely-meshed capillary layer and a more superficial venous layer from which the venæ vorticosæ arise. The short posterior ciliary arteries pass forwards between the two layers.

The eyeball in which the outer surface of the choroid is exposed should be immersed in water and the pigment washed out of it by means of a

camel-hair brush. The venules will then appear as white curved lines that converge towards the four or five points where the venæ vorticosæ take origin (Fig. 155).

Ciliary Body.—The ciliary body is separable into (1) a posterior part called the ciliary ring, (2) an anterior part called the ciliary muscle, and (3) an internal part made up of a number of ridges called the ciliary processes.

The *ciliary ring* is a vascular and nervous zone, about a sixth of an inch wide, immediately in front of the choroid, with which it is continuous.

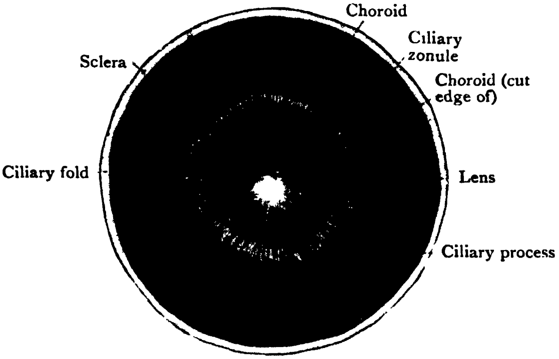


FIG. 156.—Posterior View of Lens and Ciliary Zonule. (Arthur Thomson.)

The **ciliary muscle** is composed of involuntary muscular tissue. The arrangement of its fibres can be seen only when thin sections of the eyeball are examined under the microscope. It is then obvious that the fibres are disposed in two groups, viz., a radiating and a circular.

The *radiating fibres* arise from the deep surface of the sclera close to the cornea, and radiate backwards into the ciliary ring and processes. The *circular fibres* are arranged in two or three bundles that lie on the deep surface of the radiating portion, and form a muscular ring around the iris.

The ciliary muscle is supplied through the short ciliary nerves by fibres of the oculomotor nerve that are relayed in the ciliary ganglion. Its action is explained on p. 373.

Dissection.—**To obtain a view of the ciliary processes, make a coronal section through an eyeball a short distance in front of the equator. Remove the portion of the vitreous body which**

occupies the anterior segment of the specimen. The deep surface of the ciliary processes will then be seen. They radiate backwards from the circumference of the lens. Wash out the pigment from the anterior part of the middle coat, in order to display the arrangement of the processes more fully.

A second dissection may be made, in another eyeball, with the object of exposing the ciliary processes from the front. In that specimen, remove the cornea by cutting round the corneoscleral junction with the scissors. The iris is then brought conspicuously into view, and may, with advantage, be studied at this stage. Next, make several radial cuts, at equal intervals, through the anterior part of the sclera. Then, place the specimen in a cork-lined tray filled with water, and separate the strips of sclera from the ciliary muscle, bend them aside and pin them to the cork. Lastly, remove the iris.

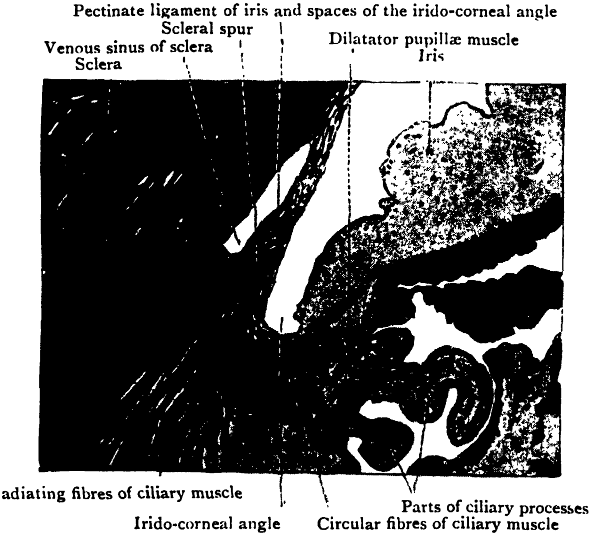

Pectinate ligament of iris and spaces of the irido-corneal angle
Scleral spur
Venous sinus of sclera
Dilatator pupillæ muscle
Sclera
Iris
adiating fibres of ciliary muscle
Parts of ciliary processes
Irido-corneal angle
Circular fibres of ciliary muscle

FIG. 157.—Section of Irido-Corneal Angle. (Arthur Thomson.)

The *ciliary processes* are deep to the ciliary muscle and ring; they are continuous, anteriorly, with the iris, and, posteriorly, with the choroid. They are about 70 in number, and begin at the anterior margin of the choroid, whence they extend forwards to end in bulbous nodules which occupy the space between the peripheral margin of the iris and the margin of the anterior surface of the lens, and form the peripheral boundary of the posterior chamber of the eyeball. The deep surface of the ring of processes is in relation with the hyaloid membrane, which separates them from the vitreous body, and also with the peripheral part of the ciliary zonule (see p. 373), to which they are attached.

Iris.—The iris lies in front of the lens, and it is separated from the cornea by the anterior chamber filled with aqueous humour. By its circumference it is continuous with the ciliary body, and it is connected, by the pectinate ligament of the iris, with the margin of the cornea.

The iris is circular in outline; its colour varies greatly; and it has a central perforation termed the *pupil.* Its anterior surface is faintly striated in a radial direction. Its posterior surface is deeply pigmented. The pupil is very nearly circular (in the sheep and ox, it is greatly elongated transversely), and during life it constantly varies in its dimensions so as to control the amount of light which is admitted into the interior of the eyeball. The changes in the size of the pupil are produced by the two groups of involuntary muscular fibres that lie in the substance of the iris; one is arranged circularly around the pupil in the form of a *sphincter pupillæ*; the other passes radially from the sphincter towards the circumference of the iris, so as to constitute a *dilator pupillæ muscle.*

Ciliary Nerves.—There are two sets of ciliary nerves—short and long. The *short ciliary nerves* arise from the ciliary ganglion and subdivide to form twelve or more filaments which pierce the sclera around the optic nerve, and extend forwards between the sclera and the choroid. They will be seen as delicate white filaments in the specimen in which the sclera has been turned aside in separate flaps (Fig. 155). In the posterior part of the eyeball, they occupy grooves on the deep surface of the sclera, and can be separated from it only with difficulty. Reaching the ciliary zone, they break into terminal branches which join in a plexiform manner and send twigs to the ciliary muscle, the iris, and the cornea. The short ciliary nerves contain:—(1) sensory fibres from the naso-ciliary nerve; (2) parasympathetic motor fibres derived from the oculo-motor nerve and relayed in the ciliary ganglion for the supply of the ciliary muscle and the sphincter pupillæ; and (3) sympathetic fibres that pass through the ganglion (without relay) and supply the blood-vessels of the eyeball.

The *lesser arterial circle* is the name applied to a second arterial ring in the iris at the outer border of the sphincter pupillæ.

The *anterior ciliary arteries* are very small twigs which arise from the branches of supply to the recti muscles. They pierce the sclera close to the cornea, take part in the formation of the greater circle, and send twigs to the ciliary processes.

Venæ Vorticosæ.—From each venous vortex in the choroid a large vein arises, and makes its exit from the eyeball by piercing the sclera obliquely a short distance behind the equator. They are four or five in number, and they end in the ophthalmic veins.

Dissection.—Dislodge the vitreous body and retina from the posterior part of the specimen which was cut into two for the purpose of exposing the ciliary processes from behind. By raising the choroid coat from the deep surface of the sclera, under a flow of water from the tap, the dissector will bring into view the venæ vorticosæ as they enter the deep surface of the sclera. When the venæ vorticosæ are divided, and the separation of the two coats is carried backwards towards the optic entrance, the short posterior ciliary arteries will be seen as they emerge from the sclera and enter the posterior part of the choroid.

To expose the external surface of the retina, take the specimen from which the sclera and cornea have been removed, and carefully strip off the iris, ciliary processes, and choroid, piece-meal, under water.

Retina.—The retina is composed of two strata—viz., a thin *pigmentary layer*, which adheres to the deep surface of the choroid, and has been removed with it, and a delicate *nervous layer*, which is moulded on the surface of the vitreous body, but is not attached to it except at the entrance of the optic nerve. The retina extends forwards beyond the equator of the eyeball, and, a short distance from the ciliary ring, it appears to end in a well-defined, wavy or festooned border termed the *ora serrata.* This appearance, however, is deceptive. The nerve elements, it is true, come to an end along the ora serrata, but an exceedingly thin lamina in continuity with the retina is in reality prolonged forwards as far as the margin of the pupil.

During life the *retina proper* is transparent, but after death it soon assumes a dull greyish tint and becomes opaque. Posteriorly, it is tied down at the entrance of the optic nerve.

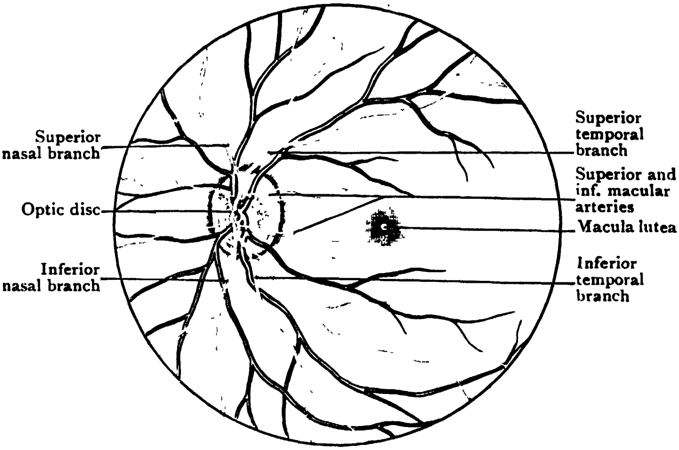


FIG. 158.—Blood-Vessels of Retina.

When viewed from the front, the optic entrance appears as a conspicuous circular elevation termed the *optic disc*, which is slightly hollowed out or "cupped." From that spot the optic nerve fibres radiate out so as to form the deep or anterior layer of the retina. The optic disc, in correspondence with the entrance of the optic nerve, lies to the medial or nasal side of the antero-posterior axis of the eyeball. Exactly in the centre of the human retina, and therefore in the axis, there is a small yellowish spot, termed the ***macula lutea***; and in its centre there is a slight depression called the ***fovea centralis.*** (There is no macula in the eyes of the ox or sheep.)

Retinal Arteries and Veins.—In a fresh eyeball the ***arteria retinæ centralis*** will be seen entering the retina at the optic disc. It divides at once into a superior and an inferior division, and each of these breaks up into a large lateral or temporal division and a smaller medial or nasal division. The various branches of the terminal divisions ramify in the retina as far as the ora serrata ; *but they do not anastomose with each other, nor with any of the other arteries in the eyeball.*

The *retinal veins* converge upon the optic disc, and disappear into the substance of the optic nerve in the form of two small trunks which soon unite.

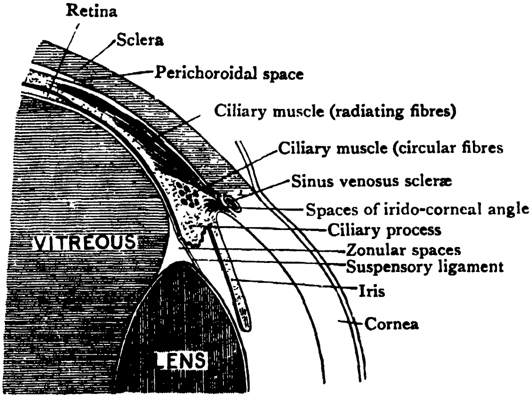


FIG. 159.—Diagrammatic representation of the Ciliary Region, as seen in vertical section.

The retinal vessels, the optic disc, and the macula can all be examined in the living eye by means of the ophthalmoscope ; the retinal vessels are vividly outlined, for their walls are transparent and the blood is seen through them. The " red reflex " obtained from the fundus of the eyeball, so examined, is produced by the blood in the deeper layer of the choroid.

Dissection.**—For the study of the vitreous body and the lens, it is better to take an eyeball which is not perfectly fresh, and one of the specimens was set aside for that purpose. Divide the coats of the eye round the equator ; gently separate the cut edges, and turn the coats forwards and backwards, and the lens and vitreous body will slip out in one piece, and should be dropped in strong picro-carmine solution for a few minutes. When removed from the staining fluid, it should be well washed in water.**

In this way the hyaloid membrane, the capsule of the lens, and the ciliary zonule are stained red, and their connexions become very apparent.

Vitreous Body.—This is a soft, yielding, transparent, jelly-like body which occupies the posterior four-fifths of the interior of the eyeball. The retina is spread over its surface as far forwards as the ora serrata, but is in no way attached to it, except at the optic disc. In front of the ora serrata, the ciliary processes are applied to the vitreous body and indent its surface. Farther forwards, it presents a deep concavity, called the *hyaloid fossa,* for the reception of the posterior surface of the lens.

The substance of the vitreous body is enclosed within a delicate transparent membrane called the *hyaloid membrane.* A minute central canal runs forwards through it from the optic disc to the lens. It is called the *hyaloid canal,* and represents the path taken by a branch of the arteria retinæ centralis which, in the fœtus, extends to the capsule of the lens and supplies it, but afterwards disappears.

The hyaloid canal, as a rule, cannot be seen in an ordinary dissection of the eyeball. It is represented diagrammatically in Fig. 153.

Ciliary Zonule.—This is a goffered fibrous ribbon closely applied to the back of the ciliary processes, fitting into the grooves between them. Its deep surface is fused with the hyaloid membrane, of which it may be regarded as a thickened part. At its internal margin, it splits into two layers. The posterior layer is an exceedingly delicate lamina which lines the hyaloid fossa. The anterior layer is stronger, and is called the **suspensory ligament of the lens.** This ligament is attached, mainly, to the anterior surface of the capsule of the lens a short distance beyond its margin, but that is not its only attachment. Some of its fibres are attached to the circumference of the lens, whilst others are fixed to its posterior surface close to its margin.

In that way the lens is firmly held in its place in the hyaloid fossa. Further, the degree of tension of its suspensory ligament is influenced by the radiating fibres of the ciliary muscle, which by their contraction pull forwards the ciliary processes and zonula, and thus relax the suspensory ligament.

The *zonular spaces* are the intercommunicating spaces enclosed in the suspensory ligament at its multiple attachment to the lens. They constitute a multilocular lymph-space around the margin of the lens.

If the point of a fine blow-pipe is introduced into the suspensory ligament at its attachment to the lens, the spaces can be partially or, perhaps, completely inflated with air, and present collectively the appearance of a circular sacculated canal.

Dissection.—**Remove the lens by snipping through the suspensory ligament with scissors.**

Lens.—The lens is a biconvex, solid, and transparent structure which lies between the iris and the vitreous body, enclosed within a glassy, elastic **capsule.**

The *anterior surface* of the lens is not so highly curved as the posterior surface. Its central part looks through the pupil into the anterior chamber of the eye. Around that part the margin of the pupil is in contact with the lens, but nearer the equator the anterior surface of the lens is separated from the iris by the aqueous humour in the posterior chamber. The *posterior surface* is received into the hyaloid fossa of the vitreous body. The *equator* is a blunt margin, and forms one of the boundaries of the zonular spaces.

Dissection.—**Incise the anterior wall of the capsule with a sharp knife. A little pressure will cause the body of the lens to escape through the opening. The stained capsule can be very advantageously studied as it floats in water.**

If the lens body is compressed between the finger and thumb, it will be noted that the outer portion or *cortical part* is soft, whilst the central part or *nucleus* is distinctly firmer. When the lens is hardened in alcohol it can easily be proved that it is composed of numerous concentrically arranged laminæ.

Chambers of Eyeball.—The *anterior chamber* is the space that separates the cornea from the iris and the central part of the lens. At the irido-corneal angle it is bounded by the pectinate ligament, and there the aqueous humour which fills this chamber finds access to the spaces of that angle.

The *posterior chamber* is a circular space that separates the back of the iris from the circumferential part of the anterior face of the lens. Peripherally, the posterior chamber is closed by the ends of the ciliary processes. It also is filled with aqueous humour.

because its surface is cleft by a large number of narrow, closely-set fissures. The *pons* is the white, bulging bridge seen between the two halves of the cerebellum. The

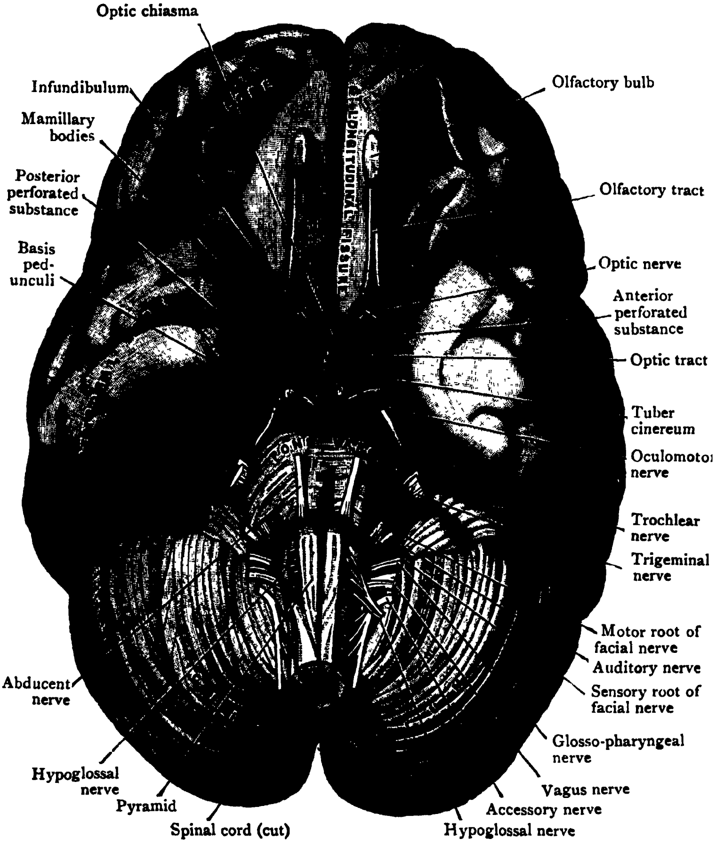


FIG. 160.—Base of Brain with Cranial Nerves attached.

medulla oblongata is the white body that extends downwards from the pons, and terminates in a flat cut end where it was severed from the spinal cord when the brain was removed. The *mid-brain* is above the pons. It is a short, thick isthmus that lies in the notch of the tentorium, and connects the pons and cerebellum with the cerebrum. Only part of it can be seen in the uncut brain—and that not very clearly if the brain was hardened in the skull. Press the pons gently downwards and backwards, and note a pair of thick, white rope-like bodies that extend upwards from the pons and sink into the cerebrum. They form the most anterior part of the mid-brain, and each of them is called a *basis pedunculi.*

The mid-brain, pons and medulla oblongata, together, form a thick stalk called the *brain-stem.* The cerebellum, pons and medulla oblongata lie in the posterior cranial fossa below the tentorium, and the three of them together are called the *hind-brain.* The name *fore-brain* is sometimes given to the cerebrum.

The brain consists of two substances—grey matter and white matter. The *white matter* is made up of nerve-fibres and neuroglia. The *grey matter* is made up of nerve-cells and nerve-fibres and neuroglia. The *neuroglia* consists of innumerable multitudes of minute cells with long, branching processes which twine round the nerve-cells and nerve-fibres, and bind them all together into one mass. In the brain-stem, the white matter is at the surface and the grey matter is inside. In the cerebrum and cerebellum, the white matter is inside; most of the grey matter is at the surface, but there are various collections of grey matter inside also. The grey matter of the surface is called the *cortex.*

Examine the parts of the hind-brain first—beginning with the **pons.** A shallow median groove extends from its lower border to its upper border, and accommodates a large artery called the basilar artery. On each side, the pons becomes narrower, and plunges into the cerebellum. The part that enters the cerebellum is called the *middle cerebellar peduncle.* The dividing mark between pons and peduncle is the trigeminal nerve—the thick nerve attached to the side of the pons.

Now, look at the **medulla oblongata.** A *median fissure* divides the front of it into a right and a left half. The bundle on each side of the fissure is called the *pyramid.* Open up the lower part of the fissure, and note that each pyramid breaks up into fasciculi which cross the fissure obliquely, interdigitating with the fasciculi of the opposite pyramid. That interdigitation is called the *decussation of the pyramids.* The *olive* is the oval eminence that is lateral to the upper part of the pyramid ; and lateral to it, and farther back, there is a thick, round bundle called the *inferior cerebellar peduncle* (restiform body).

The *hypoglossal nerve* is attached by a row of rootlets to the front of the medulla between the pyramid and the olive. Three nerves—the *glosso-pharyngeal*, *vagus* and *accessory*—are attached by a row of rootlets to the side of the medulla, in that order from above downwards. The *facial* and *auditory* nerves are attached, close together, to the lower border of the pons, at the upper end of the inferior peduncle—the facial being medial to the auditory. The *abducent nerve* is attached to the lower border of the pons, at the upper end of the pyramid.

Cut across the middle of the mid-brain (if that has not been done already) ; remove the hind-brain (with the lower half of the mid-brain) from the rest of the brain, and examine the **cerebellum.** It has a pair of *hemispheres* united by a median part which is called the *vermis* from its resemblance to a worm (Figs. 228, 229). The upper surface of the vermis is called the *superior vermis* ; it rises up as a median ridge on the upper surface of the cerebellum, but is in unbroken continuity with the upper surface of each hemisphere. The *inferior vermis* is the lower part of the vermis ; it juts down into a wide gap between the lower parts of the two hemispheres. That gap is called the *vallecula of the cerebellum.* Pull the cerebellum and the medulla oblongata gently apart to see portions of the vallecula and inferior vermis. The vermis and hemispheres are made up of a large number of thin leaves or *folia* separated by deep, narrow fissures. On the lower surface of each·hemisphere, note one small semi-detached part made up of a few short folia. It lies on the lower part of the middle peduncle, and is called the *flocculus.* It is easily recognised, and is a ready guide to the auditory and facial nerves, which are close to its medial side.

Within the hind-brain there is a cavity called the *fourth ventricle of the brain.* It separates the cerebellum from the pons and the upper part of the medulla oblongata ; in the undissected brain, it is almost completely closed in, but a good view of it can be obtained if the cerebellum (or the whole hind-brain) is entirely bisected (Fig. 161).

Turn now to the **mid-brain,** and inspect its cut surface. A small hole is seen near the back. That is the cross-section of a narrow canal, called the *aqueduct*, which tunnels the mid-brain lengthwise. Inferiorly, it opens into the fourth ventricle; superiorly, it opens into a space in the cerebrum called the third ventricle.

Draw a line across the cut surface of the mid-brain immediately behind the aqueduct. That line divides the mid-brain into two parts:—(1) a pair of *cerebral peduncles* in front of the line, partly joined together; and (2) a thin layer behind the line called the *tectum*, whose dorsal surface is heaped up into four low, rounded hillocks called the *corpora quadrigemina*. When the mid-brain is cut across, the knife usually passes between the superior pair of corpora quadrigemina and the inferior pair; and the inferior corpora are therefore probably present in the part under inspection. Pull the superior vermis of the cerebellum and the adjoining parts of the hemispheres gently backwards and the lower part of the mid-brain forwards, and note a pair of large, smooth, round bundles that issue out of the cerebellum and disappear into the mid-brain under the inferior corpora quadrigemina. These are the *superior cerebellar peduncles*. They are connected together by a small, thin white sheet called the *superior medullary velum*. The *trochlear nerve* emerges through the velum, and curves forwards round the side of the mid-brain.

Each cerebral peduncle is subdivided into three parts, named tegmentum, substantia nigra and basis pedunculi. The *basis pedunculi* is the thick, white part in front, and is entirely free from its fellow of the opposite side; it was seen when the main parts of the brain were first identified. The *tegmentum* is the large grey part in front of the tectum; nearly all of it is united to its fellow in the median plane. The *substantia nigra* is the thin plate of dark-coloured substance between the tegmentum and the basis pedunculi. The *oculomotor nerve* arises in the grey matter around the aqueduct; its fibres, curving forwards, pass through the medial edge of the substantia nigra, and emerge through the floor of the groove at the medial side of the basis pedunculi.

Place the two parts of the brain together again. Examine the basis pedunculi more fully, and then proceed to examine certain parts of the cerebrum which are seen in the base of the brain.

The *basis pedunculi*, traced downwards, disappears into the pons, close to its fellow. As it is traced upwards, it diverges from its fellow, and sinks into the cerebrum. In the cerebrum, it becomes continuous at once with a flat, thick mass of white matter, called the *internal capsule*, which will be seen later when the cerebrum undergoes complete dissection. Before the basis sinks into the cerebrum, it is overlapped by a part of the cortex called the *uncus*. Push the uncus gently aside, and note a flat, white band that curves round the upper end of the basis. That is the *optic tract*. Trace it forwards. It joins a white cross-piece, called the *optic chiasma*, which connects it with the optic tract of the opposite side. The *optic nerve* is the cut white bundle attached to the chiasma in front of the tract.

The **interpeduncular fossa** is the space enclosed by the pons, the cerebral peduncles, and the optic tracts and chiasma. In that fossa, note the following parts:—(1) A pair of white, pea-like bodies called the *mamillary bodies*; behind them, (2) the *oculomotor nerve* on each side, and in the middle, (3), a depression whose floor is formed of grey matter perforated by blood-vessels and called the *posterior perforated substance*; (4) a grey elevation in front of the mamillary bodies. This elevation is called the *tuber cinereum*, and is prolonged into a narrow funnel called the *infundibulum*. The infundibulum connects the tuber cinereum with a structure called the *hypophysis*. The hypophysis, however, cannot be seen now, for, when the brain was removed, the infundibulum was cut, or torn, and the hypophysis was left in the skull.

Look now to the lateral side of the optic chiasma, and note a depression barely big enough for the finger-tip. It is called the *vallecula of the cerebrum*. Its floor is formed of grey matter perforated by blood-vessels and called the *anterior perforated substance*. This grey substance is continuous superiorly with the *basal nuclei*. These nuclei cannot be seen at present, for they are collections of grey matter in the interior of the cerebrum; but the names of the two largest must be noted now. These are two big masses of grey matter called the *lentiform nucleus* and the *caudate nucleus*; they clasp the internal capsule between them and are connected together by bars of grey matter that pass through the capsule, and therefore are often referred to under one name—the *corpus striatum*.

Pull back the optic chiasma very carefully, and look for a very thin and fragile sheet of grey matter, called the *lamina terminalis*, which extends upwards from the front of the chiasma. The bisected lamina will be seen again, when the medial side of the half of the cerebrum is examined (Fig. 161).

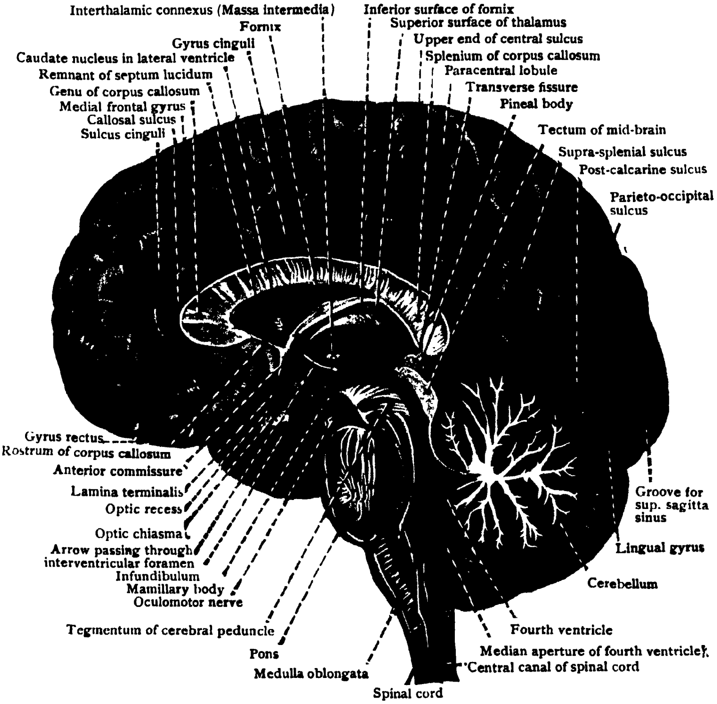


FIG. 161.—Medial Surface of Right Half of bisected Brain. The Septum Lucidum has been removed to expose the Lateral Ventricle. The arrow passes through the Interventricular Foramen from the lateral ventricle to the third ventricle, and lies in the Hypothalamic Sulcus.

The cerebrum as a whole now remains to be examined. Its right and left halves are called the cerebral hemispheres,[1] and are to a large extent separate from each other. The separation is effected chiefly by a deep, narrow median cleft. The cleft is called the *longitudinal fissure*, and, when the brain is in the skull, it is occupied by the falx cerebri. The division is complete in front and behind ; but, in the middle, the hemispheres are united by a number of structures, the largest of which is the *corpus callosum*—a long, wide, thick sheet of white matter. Pull the hemispheres gently apart. The corpus callosum is the white structure then seen forming a floor for a great part of the longitudinal fissure.

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[1] For ordinary descriptive purposes, it is convenient to retain the original significance of the term " cerebral hemisphere "—the whole half of the cerebrum. When the brain is dealt with developmentally, the term has a more restricted meaning.

Each hemisphere has three surfaces—supero-lateral, medial and inferior. The *supero-lateral surface* is the convex surface. The *medial surface* is flat. The *inferior surface* is uneven, and is divided into two parts by a deep, wide horizontal cleft; the posterior part is called the *tentorial surface* because a great part of it lies on the tentorium cerebelli; the anterior part of the inferior surface is the smaller part, and is called the *orbital surface* because most of it lies on the roof of the orbit. The *olfactory tract* is the slender, white band that lies free on the orbital surface near its medial border, and nearly parallel to that border. Trace it backwards and forwards. Its anterior half-inch is slightly swollen and is called the *olfactory bulb*, and gives attachment to the *olfactory nerves* (which were torn off when the brain was removed). The posterior end divides into two diverging *roots*, which are fused with the surface of the brain, and form the anterior boundary of the anterior perforated substance.

The cleft between the orbital and tentorial surfaces is called the *stem of the lateral sulcus*. The stem begins at the vallecula, and runs horizontally to the supero-lateral surface. There, it divides into three rami. Two of the rami are short, and their identification—which is sometimes difficult—may be deferred. The *posterior ramus* is important, as it separates well-defined portions of the surface. It is a deep, long cleft which extends backwards for nearly three inches, and then turns abruptly upwards to end at or near the most convex spot on the supero-lateral surface. The *insula* is a submerged part of the cortex, hidden in the bottom of the lateral sulcus. Open up the stem and posterior ramus to see the insula. The boundaries of the stem and rami of the lateral sulcus overlie and conceal the insula, and are called therefore the *opercula*. (*Operculum* means a lid or cover).

The anterior end of the hemisphere is called the *frontal pole*; its posterior end is the *occipital pole.* The *temporal pole* is the blunt, anterior end of the tentorial surface.

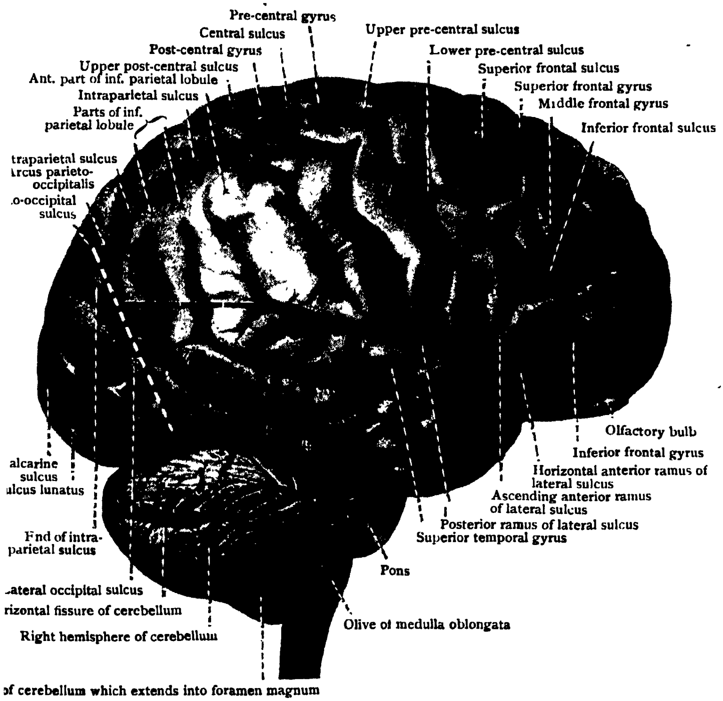
Pre-central gyrus
Central sulcus
Post-central gyrus
Upper post-central sulcus
Ant. part of inf. parietal lobule
Intraparietal sulcus
Parts of inf. parietal lobule
traparietal sulcus
lrcus parieto-occipitalis
.o-occipital sulcus
Upper pre-central sulcus
Lower pre-central sulcus
Superior frontal sulcus
Superior frontal gyrus
Middle frontal gyrus
Inferior frontal sulcus
Olfactory bulb
Inferior frontal gyrus
Horizontal anterior ramus of lateral sulcus
Ascending anterior ramus of lateral sulcus
Posterior ramus of lateral sulcus
Superior temporal gyrus
Pons
Olive of medulla oblongata
alcarine sulcus
ulcus lunatus
End of intra-parietal sulcus
.ateral occipital sulcus
rizontal fissure of cerebellum
Right hemisphere of cerebellum
of cerebellum which extends into foramen magnum

FIG. 162.—Lateral Surface of Right Half of Brain (semi-diagrammatic). The horizontal dotted line completes the separation between the parietal and temporal lobes, and the oblique dotted line, which runs from the parieto-occipital sulcus to the pre-occipital notch, separates the occipital lobe from the parietal and temporal lobes.

The surfaces of the hemisphere are limited by borders. Run the finger along them. The upper margin of the hemisphere is called the *supero-medial border*; it extends from the frontal pole to the occipital pole, between the medial and supero-lateral surfaces. The *infero-lateral border* extends from the occipital pole to the temporal pole, and separates the tentorial surface from the supero-lateral surface. On this border, about an inch and a half in front of the occipital pole, there is a shallow notch called the *pre-occipital notch.* The *superciliary border* is in front. It begins at the frontal pole, and curves round, between the orbital and supero-lateral surfaces, to the end of the stem of the lateral sulcus. The *medial orbital border* extends backwards from the frontal pole towards the chiasma, and separates the orbital surface from the medial surface. The *medial occipital* is the blunt border between the posterior parts of the tentorial and medial surfaces; it extends from the occipital pole to the corpus callosum. The *hippocampal border* is the medial margin of the tentorial surface in front of that; it is a blunt edge that bounds the gap between the tentorial surface and the mid-brain, and receives its name because it is the medial margin of a part of the cortex called the hippocampal gyrus.

The surfaces of the hemisphere are traversed by a large number of grooves called the *sulci* of the hemisphere. The sulci are of varying lengths and depths and shapes; many of them are named, but there are many small variable unnamed sulci. The areas and blunt, winding ridges between the sulci are called *gyri.*

No two brains are quite alike in their surface pattern, and even the two halves of the same brain differ; but many of the sulci and gyri are sufficiently constant in shape and position to be recognised in any brain. The sulci to be identified first are those employed to divide the hemisphere into lobes. They are the lateral, the central and the parieto-occipital sulci.

The stem and posterior ramus of the *lateral sulcus* have been identified already.

The *central sulcus* is important, because, as will be explained later, it separates the motor and sensory areas of the cortex. It begins about half an inch behind the middle point of the supero-medial border, and runs sinuously forwards and downwards to end near the posterior ramus of the lateral sulcus about an inch behind the beginning of that ramus. It is therefore near the middle of the supero-lateral surface.

The *parieto-occipital sulcus* is a nearly vertical cleft on the medial surface about an inch and a half in front of the occipital pole; it is nearly an inch in depth, and its upper end cuts into the supero-lateral surface.

" Lobes " is a term used to indicate certain artificial subdivisions of the hemisphere. It is not of much service in the description of the inferior and medial surfaces, but its use makes the description of the supero-lateral surface more precise. The lobes are named frontal, parietal, temporal

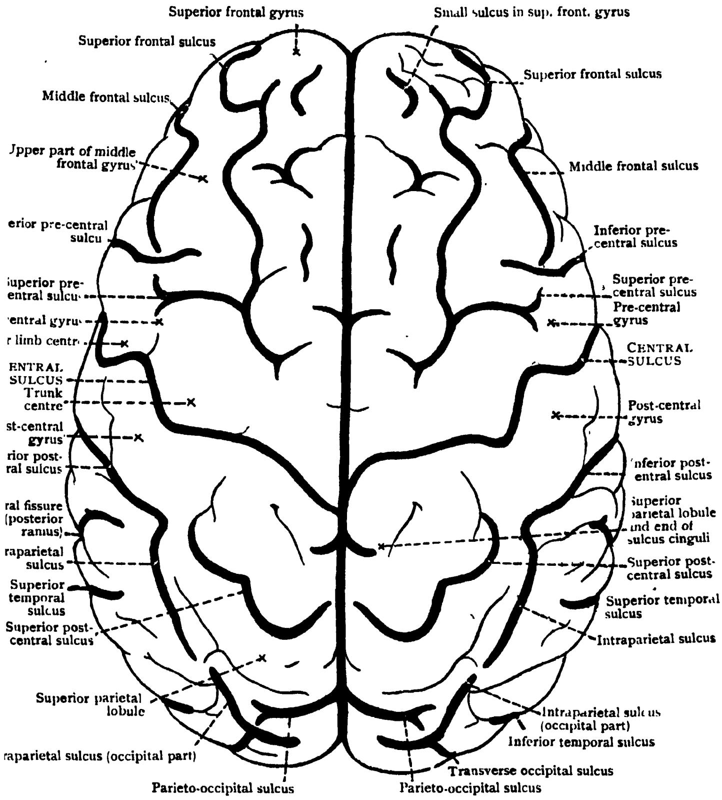

FIG. 163.—Cerebral Hemispheres from above (diagrammatic).

and occipital; and, on the supero-lateral surface, they are separated from one another by three sulci and two artificial lines. These boundary sulci are the parieto-occipital sulcus, the central sulcus, and the posterior ramus of the lateral sulcus. The imaginary lines are:—(1) A line drawn from border, about an inch and a half in front of the occipital pole, there is a shallow notch called the *pre-occipital notch*. The *superciliary border* is in front. It begins at the frontal pole, and curves round, between the orbital and supero-lateral surfaces, to the end of the stem of the lateral sulcus. The *medial orbital border* extends backwards from the frontal pole towards the chiasma, and separates the orbital surface from the medial surface. The *medial occipital* is the blunt border between the posterior parts of the tentorial and medial surfaces; it extends from the occipital pole to the corpus callosum. The *hippocampal border* is the medial margin of the tentorial surface in front of that; it is a blunt edge that bounds the gap between the tentorial surface and the mid-brain, and receives its name because it is the medial margin of a part of the cortex called the hippocampal gyrus.

The surfaces of the hemisphere are traversed by a large number of grooves called the *sulci* of the hemisphere. The sulci are of varying lengths and depths and shapes; many of them are named, but there are many small variable unnamed sulci. The areas and blunt, winding ridges between the sulci are called *gyri*.

No two brains are quite alike in their surface pattern, and even the two halves of the same brain differ; but many of the sulci and gyri are sufficiently constant in shape and position to be recognised in any brain. The sulci to be identified first are those employed to divide the hemisphere into lobes. They are the lateral, the central and the parieto-occipital sulci.

The stem and posterior ramus of the *lateral sulcus* have been identified already.

The *central sulcus* is important, because, as will be explained later, it separates the motor and sensory areas of the cortex. It begins about half an inch behind the middle point of the supero-medial border, and runs sinuously forwards and downwards to end near the posterior ramus of the lateral sulcus about an inch behind the beginning of that ramus. It is therefore near the middle of the supero-lateral surface.

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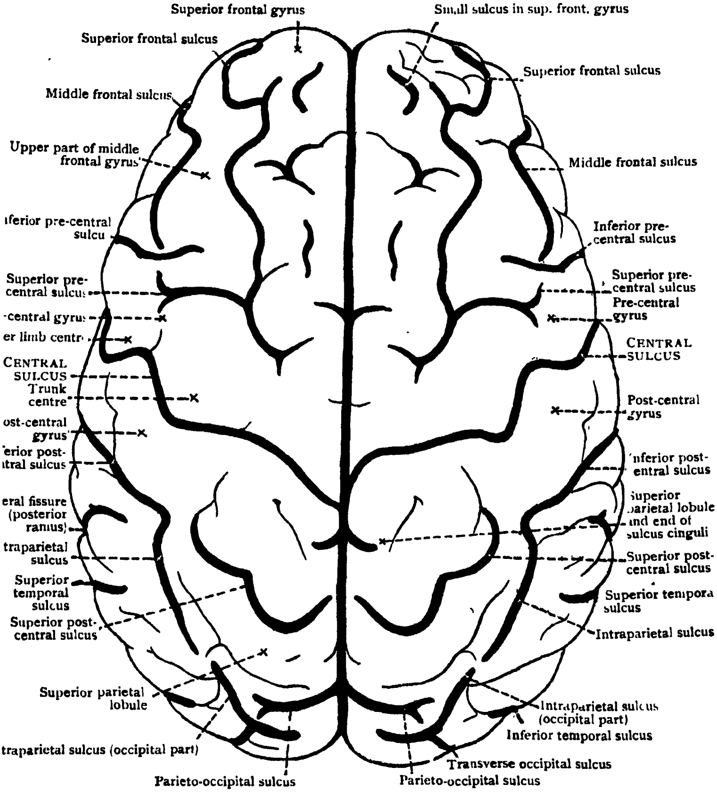

FIG. 163.—Cerebral Hemispheres from above (diagrammatic).

and occipital; and, on the supero-lateral surface, they are separated from one another by three sulci and two artificial lines. These boundary sulci are the parieto-occipital sulcus, the central sulcus, and the posterior ramus of the lateral sulcus. The imaginary lines are :—(1) A line drawn from the upper end of the parieto-occipital sulcus to the pre-occipital notch. (2) A line continued backwards from the horizontal part of the posterior ramus of the lateral sulcus till it joins the first line (Fig. 162).

The *frontal lobe* is all the part in front of the central sulcus, and is therefore much the biggest lobe. The *occipital lobe* is the part behind the first line, and is small. The *temporal lobe* is marked off by the horizontal part of the posterior ramus, by the second line and by the lower part of the first line. The *parietal lobe* is the remainder, and lies above the temporal lobe, between the upper parts of the frontal and occipital lobes.

In the interior of each hemisphere, there is a cavity called the *lateral ventricle*, which will be found after the dissection of the brain is begun. The ventricle has a *central part* from which three extensions pass in different directions; these extensions are called *horns*. The *anterior horn* extends forwards in the frontal lobe. The *posterior horn* extends backwards, tapering, into the occipital lobe. The *inferior horn* sweeps downwards into the temporal lobe, and extends forwards in it.

Certain of the other sulci should now be identified, and some of the gyri.

The *pre-central gyrus* is one of the most important, for it contains nearly the whole of the *motor area* for the opposite half of the body. It is the strip in front of the central sulcus. It is limited anteriorly by the *pre-central sulcus*, which usually is divided into two parts—superior and inferior. Two sulci run forwards from those two parts and divide the rest of the frontal lobe into *superior*, *middle* and *inferior frontal gyri*; and they, like many other gyri, are further subdivided by sulci, some of which will be referred to when the brain is examined in more detail later. The *centre for speech* is in the left hemisphere in right-handed people; it includes the posterior part of the inferior frontal gyrus and the lower part of the pre-central gyrus.

The gyrus behind the central sulcus is the *post-central.* It is the *sensory area* for most of the opposite half of the body. It is bounded posteriorly by the *post-central sulcus.*

The *superior temporal sulcus* is parallel to the posterior ramus of the lateral sulcus, and about a finger's breadth below it. The gyrus between it and posterior ramus is the *superior temporal*; the *centre for hearing* is in the middle part of that gyrus.

On the tentorial surface, the most noteworthy gyrus is the

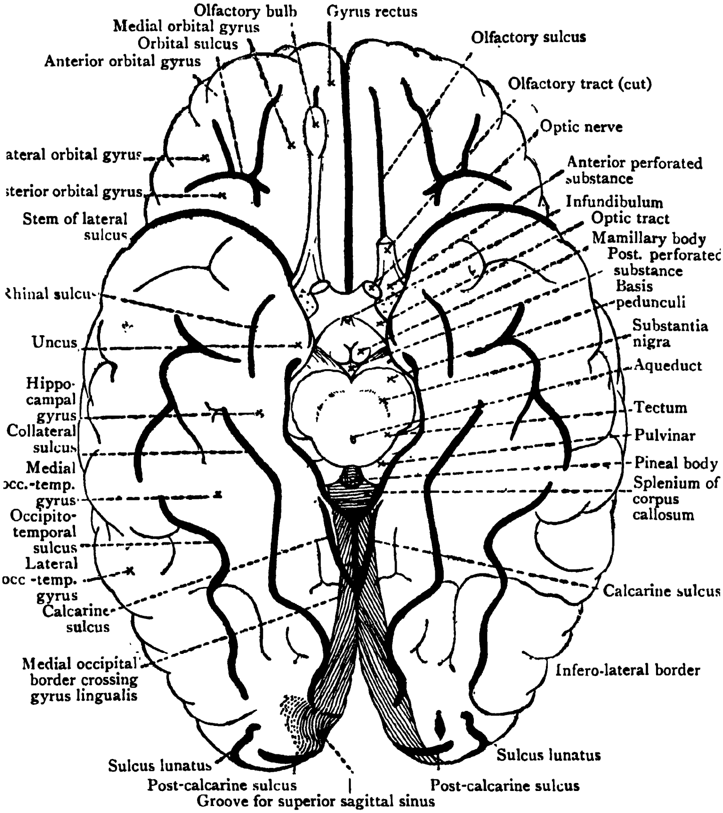

FIG. 164.—Inferior Surface of Hemispheres (diagrammatic).

hippocampal, which is bounded medially by the hippocampal border. It receives its name because of its close relation to a structure called the *hippocampus*, which, at a later stage, will be seen in the floor of the inferior horn of the lateral ventricle. The anterior end of the *hippocampal gyrus* is continuous with the *uncus*, which contains a *centre for smell*

The uncus is so named because its narrow, medial part is bent backwards in a way that gives it a slight resemblance to a hook. It has been noted already that the uncus overlaps the basis pedunculi and the optic tract. Note now that:—(1) it forms the postero-lateral boundary of the vallecula and anterior perforated substance; (2) it is separated from the temporal pole by a shallow dent called the *rhinal notch*, and is bounded laterally by a small, inconstant fissure called the *rhinal sulcus* (Fig. 164), which may be continuous with the rhinal notch; and (3) the inferior horn of the lateral ventricle ends in its interior. The fissure that bounds the hippocampal gyrus laterally is part of the *collateral sulcus*. It begins at or near the posterior end of the rhinal sulcus and extends to the occipital pole—sometimes as an undivided fissure, sometimes broken into two or more parts.

On the medial surface, note first the thick, cut edge of the corpus callosum, and use it as a landmark.

The *calcarine sulcus* begins a little below the posterior end of the corpus callosum, passes backwards and upwards to join the lower end of the parieto-occipital sulcus, and then runs on, as the *post-calcarine sulcus*, to the occipital pole. The cortex adjoining the calcarine and post-calcarine sulci contains the *centre for sight*.

The *sulcus cinguli* is about a finger's breadth from the corpus callosum. It begins below the anterior end of the corpus callosum, arches upwards in front of the anterior end, runs backwards almost as far as its posterior end, and then bends sharply upwards to terminate by cutting the supero-medial margin. It cuts that margin close behind the upper end of the central sulcus. It is fairly easily recognised, and provides a fairly certain means of identifying the central sulcus (which is not always easily recognised): the central sulcus is the one whose upper end is immediately in front of the end of the sulcus cinguli. The *gyrus cinguli* is the strip of cortex between the sulcus cinguli and the corpus callosum.

The long, wide area between the sulcus cinguli and the margin of the hemisphere is the *medial frontal gyrus*. A branch of the sulcus cinguli partly cuts off its posterior inch. That part is called the *paracentral lobule* because the upper end of the central sulcus cuts into it. It contains the *motor and sensory centres for the foot*—in front of the central sulcus and behind it, respectively.

The last stage of the preliminary survey is the identification of the parts on the medial surface that do not belong to the cortex.

First, the *corpus callosum*. It has been identified already, but examine now those of its subdivisions that are visible. Its main part is called its *trunk*. Its posterior end is thickened, and is called the *splenium*. Its anterior end is thickened and bent downwards, and is called the *genu*. The lower part of the genu is continued backwards as a thin white layer called the *rostrum*, which joins the upper end of the lamina terminalis. This union takes place on the front of a small, round white bundle, called the *anterior commissure*, which, like the corpus callosum, passes out of the substance of one hemisphere into that of the other, and has been cut across. The *lamina terminalis* is a very thin layer of grey matter that stretches down from the commissure to the front of the optic chiasma, and is now bisected ; it was looked for when the base of the brain was inspected.

Other structures already seen in the base of the brain are now seen from another point of view—one *mamillary body*, and the *divided chiasma*, *tuber cinereum* and *posterior perforated substance*. The half of the upper part of the mid-brain also is seen.

A little below the trunk of the corpus callosum, look for the cut edge of a thin, white sheet called the *body of the fornix*. The anterior end of this edge is continuous with the *anterior column of the fornix*. This column is a round bundle that curves downwards behind the anterior commissure and sinks into the hemisphere.

The *septum lucidum* is the thin, vertical sheet between the fornix and the corpus callosum. If a hole is made in it, the *anterior horn of the lateral ventricle* is opened into ; and, if the hole is big enough, the *head of the caudate nucleus* will be seen—a smooth, convex mass of grey matter.

Now, identify the *thalamus*, which is an important centre for receiving sensory impressions and transmitting them to the cortex. It is the large, smooth, grey body below the fornix. If the veins are distended with blood, a venous channel will probably be seen between the thalamus and the fornix. The posterior part of that channel is the *great cerebral vein* and its anterior part is one of the pair of *internal cerebral veins*, which unite to form the great vein. The loose tissue

The space between the right and the left thalamus is the *third ventricle* of the brain. Postero-inferiorly, the *aqueduct* connects it with the fourth ventricle. On each side, anteriorly, it communicates with the lateral ventricle by an *interventricular foramen* seen between the anterior end of the thalamus and the anterior column of the fornix.

The entire extent of the cavity of the central nervous system (ventricles, aqueduct, central canal of spinal cord and of lower half of medulla oblongata) is lined with a kind of ciliated epithelium called *ependyma*; and it is filled with a clear liquid, called the *cerebro-spinal fluid*, which is secreted by the parts of the ependyma that cover the choroid plexuses. Certain parts of the walls of the fourth ventricle consist of ependyma alone. At these parts there are apertures in the ependyma and the overlying pia mater; through these apertures the ventricles communicate with the spaces between the pia and the arachnoid (subarachnoid space), and these spaces also are filled with cerebro-spinal fluid.

MEMBRANES OF THE BRAIN

When the inspection of specimens from which the membranes have been removed is finished, the dissectors should turn to the examination of the membranes which cover their own specimen. If it was divided through the mid-brain when it was removed from the skull, place the two parts together again.

It has been stated already that the brain is surrounded by three membranes—the dura mater, the arachnoid mater and the pia mater—which are all continuous with the corresponding membranes of the spinal cord.

The dura mater is studied during the dissection of the Head (pp. 93, 124), for it is adherent to the walls of the cranial cavity, and is therefore left in the skull when the brain is removed. The arachnoid and the pia mater are removed with the brain.

Arachnoid Mater of Brain.—The arachnoid mater is an exceedingly thin and delicate membrane. It is separated from the dura mater by a capillary interval, called the subdural space, which is occupied by a film of lymph to moisten the surfaces. It is adherent to the dura mater only at the points where the nerves pierce them and carry off sheaths. Its connexion with the pia is very unequal in different parts of the brain: the pia is a close-fitting sheath and dips into all the clefts; the arachnoid, being closely related to the dura, bridges over the inequalities of the surface of the brain, and is spread out as a distinct sheet over the medulla oblongata and the pons and the hollow in front of the pons. The arachnoid is therefore seen best on the base of the brain. Only in two places does the arachnoid enter clefts of the brain:—(1) the longitudinal fissure, into which it is carried by the falx cerebri; and (2) the stem of the lateral fissure, into which it is pushed by the lesser wing of the sphenoid.

On the base of the brain, the cut ends of several of the cranial nerves will be seen passing through the arachnoid; whilst, anteriorly, immediately to the lateral side of the optic nerve, the internal carotid artery will be noticed piercing it.

Subarachnoid Space.—This is the name given to the interval between the arachnoid and the pia mater. The clear liquid which fills it is called the *subarachnoid fluid*, but is cerebro-spinal fluid which has passed into it from the ventricles of the brain. The fluid removes the waste-products of the activities of the nerve-cells; and it acts as a mobile buffer which distributes and equalises pressure inside the skull.

The subarachnoid space is broken up by a meshwork of fine filaments and trabeculæ which connect the arachnoid and the pia mater in the most intimate manner, and form a delicate sponge-like interlacement between them. Where the arachnoid passes over the summit of a gyrus, and is consequently closely applied to the pia mater, the meshwork is so close and the trabeculæ so short that the two membranes cannot be separated from each other. To the dissector they appear to form a single lamina. In the intervals between the margins of adjacent gyri, distinct angular spaces exist between the arachnoid and the pia mater. In those spaces the subarachnoid tissue can be studied, and it will be seen that the spaces serve as communicating channels for the free passage of the subarachnoid fluid from one part of the brain to another. The larger branches of the arteries and veins of the brain traverse the subarachnoid space; their walls are directly connected with the subarachnoid trabeculæ and are bathed in the subarachnoid fluid. Prolongations of the space accompany the fine branches which enter the brain substance. These perivascular channels divide to accompany the ramifications of the vessels till they ultimately surround the individual nerve-cells; and the liquid in them receives the waste-products of the cells.

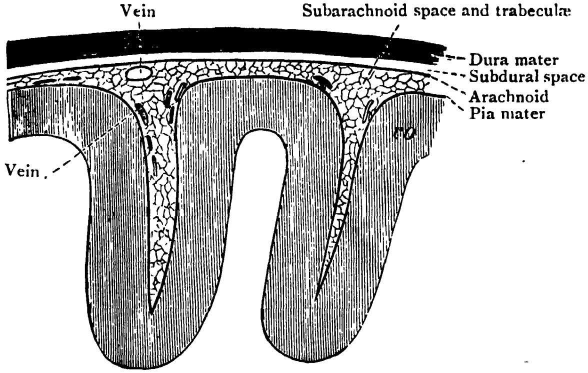

FIG. 165.—Diagrammatic Section through Meninges of Brain. (Schwalbe)

co. Grey matter of cerebral gyri.

Subarachnoid Cisterns.—In certain situations the arachnoid mater is separated from the pia mater by intervals of considerable depth and extent. These larger spaces are termed subarachnoid cisterns. In them the subarachnoid tissue is relatively reduced. There is no longer a close meshwork; the trabeculæ take the form of long filamentous intersecting threads which traverse the spaces. The dissector will obtain a beautiful demonstration of the conditions described by dividing the sheet of arachnoid which is spread over the medulla oblongata and pons, and turning the two pieces gently aside. Make the division in the median plane with scissors.

Certain of the cisterns require special mention. One of the largest is called the *cerebello-medullary cistern* (Fig. 166).

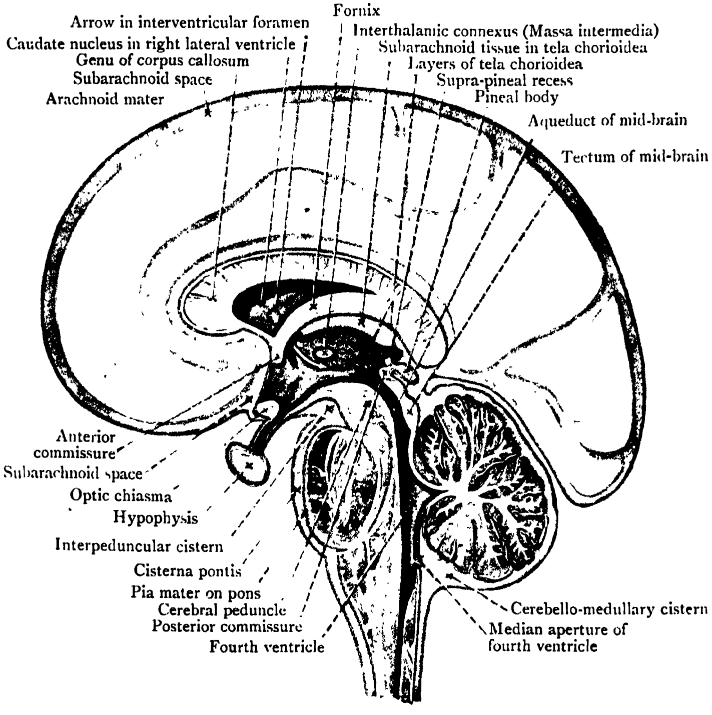

FIG. 166.—Diagram of Median Section of Brain to show Membranes and Cisterns. The *pale red* is the pia mater of the medial surface of the cerebral hemisphere. The ependyma is coloured *purple*.

It is a direct upward continuation of the posterior part of the subarachnoid space of the spinal meninges into the posterior part of the cranium. It is bounded by the arachnoid mater which bridges across the wide interval between the medulla oblongata and the lower part of the cerebellum.

The *cisterna pontis* is the name given to another of the subarachnoid spaces. It is the continuation upwards of the anterior part of the subarachnoid space of the spinal meninges, and it contains the vertebral and basilar arteries. Round the sides of the medulla oblongata, it is continuous with the cerebello-medullary cistern ; the medulla oblongata is therefore completely surrounded by a wide subarachnoid space.

In front of the pons, the arachnoid mater stretches between the two temporal lobes, and covers in the deep hollow in that region of the base of the brain. The space so enclosed is the *interpeduncular cistern*, and it contains the large arteries that take part in the formation of a ring-like anastomosis called the circulus arteriosus. The interpeduncular cistern is continuous with the *cistern of the lateral sulcus*, which extends laterally in the stem of that sulcus, and contains the middle cerebral vessels.

All the cisterns communicate freely with one another, and also with the narrow subarachnoid intervals on the surface of the cerebrum. The subarachnoid space does not communicate in any way with the subdural space ; but, as already noted (p. 390), it communicates with the ventricular system through three small openings which lead out of the fourth ventricle into the cerebello-medullary cistern.

Arachnoid Villi and Granulations.—The *arachnoid villi* are microscopic appendices of the arachnoid mater filled with subarachnoid tissue and fluid. They push their way into the venous sinuses, stretching and thinning the walls of the sinuses. They are minute in children but increase in size with age till they form pedunculated outgrowths called *arachnoid granulations*. These granulations are of the size of small peas, and not only push their way into the sinuses but may also indent the bone. They are most numerous along the superior sagittal sinus, and were seen there when the skull-cap was removed (p. 94). The subarachnoid or cerebro-spinal fluid passes by osmosis through the villi and granulations into the venous sinuses.

The dissectors should now examine the cisterns by carefully dividing the arachnoid, where that has not been done.

Dissection.—Divide the arachnoid in the median plane along the front of the medulla oblongata and the pons (if the division has not been made previously), and turn the flaps aside. The _vertebral arteries_ and the _basilar artery_ are then exposed.

Carry an incision backwards and laterally through each flap of arachnoid into the angle between the medulla oblongata and the cerebellum, and so open the cerebello-medullary cistern.

Note that a large branch of each vertebral artery, called the *posterior inferior cerebellar*, passes into the cistern on its way to the cerebellum.

Turn again to the front of the pons, and carry the median incision in the arachnoid forwards to the infundibulum, and so open the interpeduncular cistern. Note that the arachnoid which forms the lower wall of the interpeduncular cistern is perforated posteriorly, on each side, by the *oculomotor* and *trochlear nerves*, and anteriorly and more laterally by the *internal carotid artery*.

Take away the lower wall of the cistern and so expose the basilar artery as it terminates in its two *posterior cerebral* branches. Find also, on each side, the *posterior communicating artery*, which runs from the posterior cerebral to join the internal carotid.

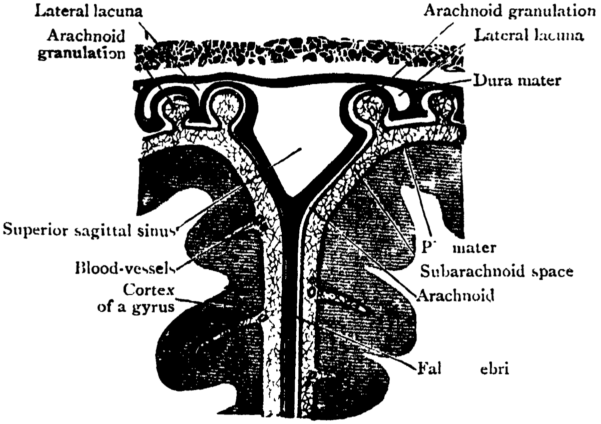

FIG. 167.—Diagram of Coronal Section through the middle portion of the Cranial Vault and subjacent Brain to show the Membranes of the Brain and the Arachnoid Granulations.

Clean the internal carotid artery and note its division into middle cerebral and anterior cerebral. Remove the arachnoid of the cistern of the lateral sulcus, and follow the *middle cerebral artery* into it. Follow the *anterior cerebral artery* medially above the optic chiasma. Draw the chiasma carefully backwards, incise the arachnoid immediately in front of it, and expose a short transverse vessel—the *anterior communicating*—which connects the right and left anterior cerebral arteries.

Do not follow the cerebral arteries farther at this stage.

Pia Mater of Brain.—The pia mater is the immediate investment of the brain. It is finer and more delicate than the pia mater of the spinal cord, and it follows closely all the inequalities on the surface of the brain. Thus, on the cerebrum, it forms a fold within every sulcus and lines both sides of the cleft. On the cerebellum, the relation is not so intimate: only the larger fissures of the cerebellum contain definite folds of pia mater.

It has been noted that the larger blood-vessels of the brain run in the subarachnoid space; the finer twigs enter the pia mater, where they ramify and anastomose before passing into the substance of the brain. As they enter the brain they carry with them sheaths derived from the pia mater. Consequently, if the dissector raises a portion of the pia mater from the surface of the cerebrum, a number of fine processes will be seen to be withdrawn from the cerebral substance. They are the blood-vessels, and they give the deep surface of the membrane a rough and flocculent appearance.

The pia mater is not confined to the exterior of the brain. A fold is carried into its interior. This will be exposed in the dissection of the brain, and will be described under the name of the *tela chorioidea of the third ventricle* (Fig. 166).

BLOOD-VESSELS OF BRAIN

The dissectors begin the study of the blood-vessels of the brain by an inspection of the veins. They will readily find and easily follow some of the venous channels, but will have considerable difficulty in tracing others from beginning to end. Indeed, they may have to refer to specially prepared specimens for confirmation of some of the points about to be noted.

The venous channels of the brain include the venous sinuses of the dura mater, and the veins which open into them. The venous sinuses were studied when the dura mater was examined (pp. 96, 106, 127).

Veins of Cerebral Hemispheres.—Most of the veins lie in the subarachnoid space on the surfaces of the hemisphere, but a few issue from the interior of the brain. One of the latter—the *great cerebral vein*—has been seen already (p. 389). It emerges from beneath the splenium of the corpus callosum, and curves upwards and backwards to terminate by joining the inferior sagittal sinus to form the straight sinus (p. 105, Fig. 36). The cut end of it can still be seen—immediately behind the splenium.

The great cerebral vein is joined by a pair of tributaries, called the *basal veins*, which curve backwards round the sides of the mid-brain. Each basal vein is formed, in the sub-arachnoid space below the anterior perforated substance, by the union of three veins, viz.: (1) the anterior cerebral vein; (2) a vein from the surface of the insula called the *deep middle cerebral vein*; and (3) the *striate vein* (or *veins*), which descends through the perforated substance from the corpus striatum in the interior. The *anterior cerebral vein* lies alongside the anterior cerebral artery, and drains the greater part of the medial surface of the hemisphere. It begins near the splenium, runs forwards over the upper surface of the corpus callosum, arches downwards in front of the genu, and then passes laterally between the brain and the optic chiasma to reach the vallecula, where it ends in the commencement of the basal vein.

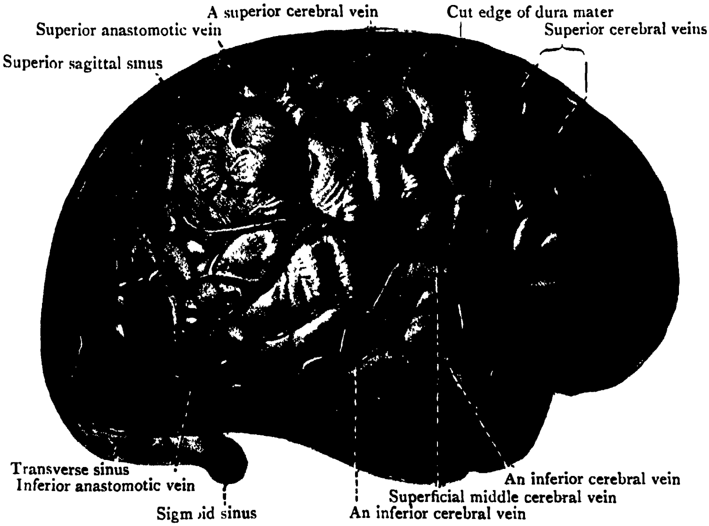
A superior cerebral vein
Cut edge of dura mater
Superior anastomotic vein
Superior cerebral veins
Superior sagittal sinus
Transverse sinus
Inferior anastomotic vein
Sigmoid sinus
An inferior cerebral vein
Superficial middle cerebral vein
An inferior cerebral vein

FIG. 168.—Veins of Supero-lateral Surface of Hemisphere, seen through the Arachnoid Mater.

It may be difficult or even impossible to demonstrate the basal vein and its tributaries if the veins are empty; but in a certain number of specimens they are found without difficulty.

Most of the veins on the medial surface of the hemisphere terminate in the anterior cerebral vein; but some end in the inferior sagittal sinus, and some ascend to the superior sagittal sinus.

The veins from the anterior part of the inferior surface of the hemisphere join the superficial middle cerebral vein and the anterior cerebral vein; those from the posterior part pass to the basal vein, to the superior petrosal sinus, to the straight sinus, and to the transverse sinus.

The veins of the supero-lateral surface of the hemisphere are divided into two groups—the superior and the inferior cerebral veins.

The *superior cerebral veins* run upwards to the supero-medial border, and end in the superior sagittal sinus (Fig. 168). They vary in number from six to twelve. The more anterior veins enter the sinus at right angles; but the more posterior veins, when they reach the sinus, run forwards for a variable distance between the sinus and the supero-medial margin of the hemisphere before they enter, and their orifices are directed obliquely forwards—that is, against the blood-stream in the sinus; those that encounter the lateral lacunæ of the sinus pass beneath them to reach the sinus.

The majority of the *inferior cerebral veins* converge upon the posterior ramus of the lateral sulcus, and end in the *superficial middle cerebral vein*, which runs forwards along the ramus and then medially along the stem of the sulcus, and ends in the cavernous sinus. Its terminal cut end will be found near the anterior part of the interpeduncular fossa.

The inferior cerebral veins that do not end in the superficial middle cerebral vein run to the infero-lateral border of the hemisphere and end in the transverse sinus.

In almost all cases the posterior end of the superficial middle cerebral vein is connected with the superior sagittal sinus by a vein called the *superior anastomotic vein*; and, very frequently, it communicates with the transverse sinus through one of the inferior cerebral veins—called the *inferior anastomotic vein*. The anastomotic veins may become of importance in cases in which the posterior part of the superior sagittal sinus or the commencements of both transverse sinuses are obstructed.

The veins from the interior of the hemispheres which join the great cerebral vein will be described later (see p. 454).

Veins of Brain-Stem and Cerebellum. The veins which return the blood from the *mid-brain* are small, and end in the basal veins.

The veins from the upper part of the *pons* join the basal veins, and those from the lower part end in the cerebellar veins and in the inferior petrosal sinuses.

The veins of the *medulla oblongata* partly end in an anterior and a posterior median vein, and partly run along the roots of the last four pairs of cranial nerves to end in the inferior petrosal sinuses, in the upper parts of the internal jugular veins, or in the pharyngeal plexus. The anterior median vein communicates with the veins of the pons and the veins of the spinal cord. The posterior median vein begins in the veins of the spinal cord, and it ends by dividing into a pair of veins that curve round the sides of the medulla to join the inferior petrosal or the network of basilar sinuses.

The veins on the upper surface of the *cerebellum* terminate in the great cerebral vein and in the superior petrosal sinuses. The veins of the lower surface end in near-by sinuses—the straight sinus, the transverse and sigmoid sinuses, the occipital sinus, and the inferior petrosal sinuses.

ARTERIES WHICH SUPPLY BLOOD TO THE BRAIN.—Two pairs of arterial trunks carry blood into the cranium for the supply of the brain—viz., the internal carotid and the vertebral. Both vertebral arteries enter through the foramen magnum, and, on each side, the internal carotid artery gains admittance through the foramen lacerum, after traversing the carotid canal. These arteries were divided when the brain was removed from the cranium. The cut end of the internal carotid will be seen close to the side of the optic chiasma. When the remains of the membranes are taken away from around it, the internal carotid will be found to divide into two branches a short distance above its cut extremity and immediately below the anterior perforated substance. The larger branch is the middle cerebral artery, which runs laterally; the smaller branch is the anterior cerebral artery, and it runs medially and forwards.

The vertebral arteries curve obliquely upwards and forwards round the sides of the medulla oblongata on to the front of it, and they unite at the lower border of the pons, in the median plane, to form the basilar artery, which runs to the upper border of the pons, where it divides into the two posterior cerebral arteries.

But the cerebral arteries which spring from the internal carotid arteries of opposite sides are brought into association with one another, and with the posterior cerebral arteries, by a remarkable and complete series of anastomoses which take place at the base of the brain, as well as by the anastomoses of their terminal branches in the pia mater on the surfaces of the hemispheres.

The anastomoses at the base of the brain constitute the circulus arteriosus, which lies mainly in the interpeduncular cistern.

Circulus Arteriosus.—This arterial circle lies in the deep hollow in front of the pons and around the optic chiasma. The so-called circle has, in reality, a heptagonal or hexagonal outline. Anteriorly, it is formed by the anterior communicating artery, which links together the two anterior cerebral arteries. On each side, the posterior communicating artery connects the internal carotid (from which the anterior cerebral springs) with the posterior cerebral. The arterial ring is completed posteriorly by the bifurcation of the basilar artery into the two posterior cerebral arteries (Fig. 170). The

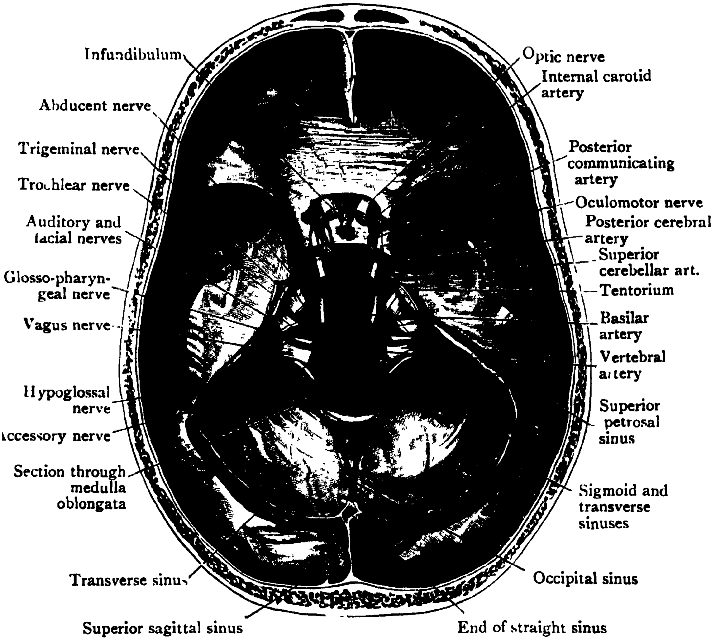

FIG. 169.—Floor of Cranium after removal of Brain and Tentorium Cerebelli. The arteries forming the Circulus Arteriosus have been left in place.

circulus arteriosus is seldom symmetrical; one posterior communicating artery is almost invariably larger than its fellow of the opposite side.

Two systems of branches—central and cortical—proceed from the cerebral arteries; both go to the cerebrum, but they differ in the manner of their distribution:—The *central branches* are very numerous and slender, and most of them come off in groups; they pierce the surface of the brain at once, and supply the internal parts of the cerebrum, including the basal nuclei; and they do not anastomose with one another. The *cortical branches* ramify over the surface of the cerebrum and supply the cortex; their branches, on their way into the cortex, ramify and anastomose in the pia mater, and, therefore, the neighbouring vascular districts of the cerebral cortex are not sharply cut off from one another.

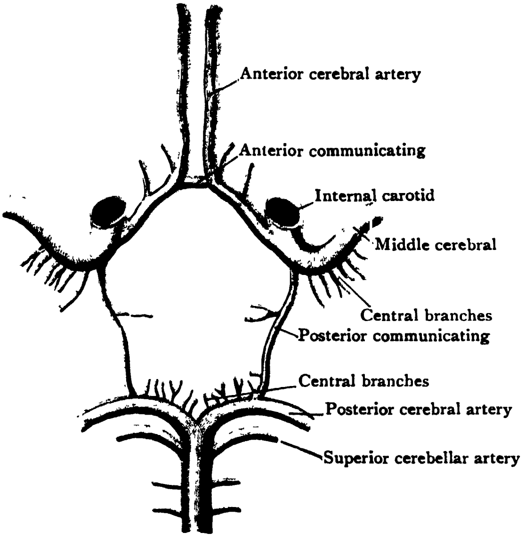

FIG. 170.—Diagram of Circulus Arteriosus.

Vertebral Artery.—Each vertebral artery enters the subarachnoid space in the upper part of the vertebral canal by piercing the dura mater and the arachnoid mater. Gaining the interior of the cranium through the foramen magnum, it runs obliquely upwards from the side of the medulla oblongata on to the front of it, and meeting its fellow in the median plane, it unites with it at the lower border of the pons to form the basilar artery. The two vertebral arteries are often unequal in size.

The branches given off from the intracranial part of the vertebral artery are :—

1. Posterior spinal.
2. Posterior inferior cerebellar
3. Anterior spinal.
4. Branches to medulla oblongata.

The *posterior spinal artery* is the first branch given off from the vertebral artery after it pierces the dura mater and arachnoid mater; and it may spring from the posterior inferior cerebellar. It passes downwards on the spinal cord along the line of the posterior nerve-roots (p. 88).

The *posterior inferior cerebellar artery* is the largest branch of the vertebral artery. It takes origin soon after the vertebral pierces the membranes, and pursues a tortuous course. It runs backwards, on the side of the upper part of the medulla oblongata, first through the lower rootlets of the hypoglossal nerve, and next behind the rootlets of the vagus and glossopharyngeal nerves, giving branches to the medulla oblongata. It then turns round the inferior cerebellar peduncle and gains the vallecula of the cerebellum, where it divides into two terminal branches which supply the inferior vermis and the posterior part of the inferior surface of the cerebellar hemisphere.

The *anterior spinal artery* arises near the lower border of the pons, and it is rare to find the vessels of the two sides of equal size. They unite to form a median vessel which extends downwards on the front of the decussation of the pyramids and spinal cord.

The *branches to the medulla oblongata* are minute vessels that spring from the vertebral artery and its branches.

Basilar Artery.—The basilar artery is formed, at the lower border of the pons, by the union of the two vertebral arteries; and it divides, at the upper border, into the two posterior cerebral arteries. It lies in the median groove of the pons, occupying the median part of the cisterna pontis; and it is supported anteriorly by the basilar portion of the occipital bone and the dorsum sellæ of the sphenoid (Fig. 169).

The majority of the branches which spring from it arise from its sides and pass laterally from it. They are :—

1. Pontine.
2. Internal auditory.
3. Anterior inferior cerebellar.
4. Superior cerebellar.
5. Posterior cerebral.

The *pontine branches* are numerous slender twigs which run laterally on the surface of the pons before they enter it.

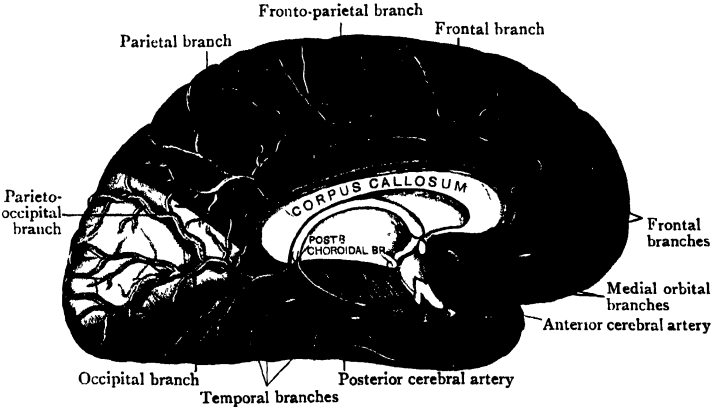

FIG. 171.—Medial and Tentorial Surfaces of Left Cerebral Hemisphere.

The district supplied by the anterior cerebral artery is tinted *purple* ; by the middle cerebral artery, *blue* ; and by the posterior cerebral artery, *red*.

The *internal auditory artery* may be seen amongst the pontine branches, but may arise from the anterior inferior cerebellar. It accompanies the auditory nerve into the internal ear.

The *anterior inferior cerebellar artery* arises from the lower part of the basilar artery, and runs backwards and laterally along the lower border of the pons, superficial to the sixth, seventh and eighth nerves, and, having made a loop around the flocculus, it divides into branches to supply the anterior part of the inferior surface of the cerebellum.

The *superior cerebellar artery* is a large vessel which springs from the basilar close to its termination. It winds laterally and backwards, round the cerebral peduncle, along the upper border of the pons, to ramify on the upper surface of the cerebellum.

Posterior Cerebral Arteries.—These two arteries diverge from each other and curve laterally and backwards round the mid-brain. In the first part of its course each of them lies deeply in the interval between the mid-brain and the hippocampal gyrus; it then enters the calcarine sulcus and divides there into two terminal branches which run onwards in the post-calcarine and parieto-occipital sulci (Figs. 171, 172).

The oculomotor nerve passes forwards between the posterior cerebral and the superior cerebellar arteries close to their origin from the basilar; and, farther back, the trochlear nerve winds round the mid-brain between them.

The branches of the posterior cerebral artery are central, choroidal and cortical.

The *central branches* are very slender. A medial group arises near the pons; they pass up through the posterior perforated substance into the interior. A lateral group arises on the side of the mid-brain; they pass to the tectum of the mid-brain and to the thalamus.

The *posterior choroidal artery* arises on the side of the mid-brain, and passes with the pia mater into the interior to supply the choroid plexuses of the ventricles. It may be represented by two or more branches.

The *cortical branches* are large arteries. They supply:—(1) the tentorial surface except a small part adjoining the temporal pole; (2) the posterior part of the medial surface; (3) the occipital lobe and the lower part of the temporal lobe on the supero-lateral surface by branches which turn round the supero-medial and infero-lateral margins. The anterior branches supply the uncus, which contains the centre for smell; and note specially that the occipital branches of the posterior cerebral artery supply the centre for sight (compare Figs. 171 and 216).

The dissectors will be able to trace the course of the artery and its cortical branches on the specimens or casts used for the preliminary study of the brain. In their own specimen, they will be able to trace the artery for only a short distance and will see only a few of its branches, especially if the mid-brain is still attached; but they will have an opportunity, later, of seeing those vessels (p. 424).

Internal Carotid Arteries.—Each internal carotid artery ends in the vallecula below the anterior perforated substance by dividing into the anterior and middle cerebral arteries. Immediately before it divides it gives off the posterior communicating artery and the anterior choroidal artery.

The *posterior communicating artery* is usually slender, and it may arise from the middle cerebral. It passes backwards across the basis pedunculi above the oculomotor nerve to join the posterior cerebral, giving off minute branches to the basis and the optic tract (Fig. 170).

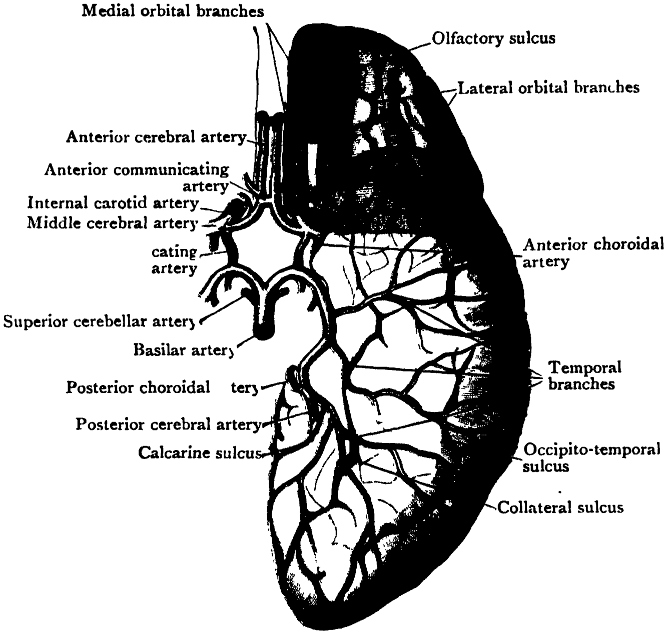

FIG. 172.—Inferior Surface of Left Cerebral Hemisphere.

The districts supplied by the three cerebral arteries are tinted differently: posterior cerebral artery, *red*; middle cerebral artery, *blue*; anterior cerebral artery, *purple.*

The *anterior choroidal artery* passes into the inferior horn of the lateral ventricle, and enters the choroid plexus in that cavity (Fig. 172).

Anterior Cerebral Artery.—The anterior cerebral artery will be seen in only a short part of its course until the medial surface of the hemisphere is exposed. In the meantime, make use again of the specimens or casts.

The artery runs first horizontally, above the optic chiasma, towards the median plane (Figs. 171, 172). Then, bending sharply, it turns upwards, in the longitudinal fissure, a little in front of the lamina terminalis, and along the rostrum to the genu of the corpus callosum, round which it bends; it then passes backwards, along the medial face of the hemisphere, on the upper surface of the corpus callosum or in the sulcus cinguli, as far as the splenium, and, finally, bends upwards to the supero-medial margin. As it enters the longitudinal fissure it is connected with its fellow of the opposite side by a short transverse channel, called the *anterior communicating artery*, which lies in front of the lamina terminalis; and, beyond that, it is near its fellow, though separated by the arachnoid mater and the falx cerebri.

The branches of the anterior cerebral artery are central and cortical.

The *central branches* are several slender twigs that pierce the lamina terminalis and the rostrum of the corpus callosum to supply parts in the interior.

The *cortical branches* supply :—(1) the medial half of the orbital surface; (2) the medial surface, from the frontal pole almost to the parieto-occipital fissure; (3) a strip of nearly an inch in width on the supero-lateral surface adjoining the supero-medial margin, by the terminal twigs of the branches that supply the medial surface (Figs. 171, 173). The branches of the anterior cerebral supply therefore the upper parts of the motor and sensory areas of the cortex.

Middle Cerebral Artery.—The middle cerebral artery is larger than the anterior cerebral, and is more in line with the internal carotid; emboli which have entered the internal carotid pass therefore more frequently into the middle cerebral than into the anterior. It runs laterally in the stem of the lateral sulcus, and, reaching the insula, breaks up on its surface into a number of large terminal branches.

The branches of the middle cerebral are central and cortical. The dissectors will be able to trace the artery and its cortical branches in their own specimen, and will see the central branches at a later stage of the dissection.

The *central branches* are numerous small arteries that pass upwards through the anterior perforated substance into the interior. They are called the *striate arteries* because they are spent chiefly in supplying the corpus striatum. They can be classed in two groups—medial and lateral. The *medial striate arteries* pass at once into the part of the corpus striatum which is called the lentiform nucleus. The *lateral striate arteries* are larger; they ascend over the lower part of the lateral surface of the lentiform nucleus, diverging from one another, and grooving the surface of the nucleus, into which they gradually sink; they then pass through the lentiform nucleus and the internal capsule (supplying them) and end in the caudate nucleus, which is the other part of the corpus striatum. These arteries are of great clinical importance, for it is rupture of one of them inside the brain that gives rise to the kind of cerebral hæmorrhage that produces an apoplexy or paralytic stroke; and the largest of them is called *the artery of cerebral hæmorrhage.*

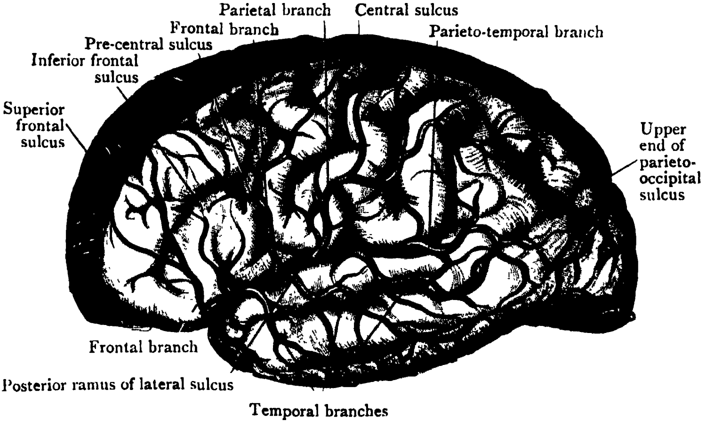

FIG. 173.—Supero-lateral Surface of Left Cerebral Hemisphere.

The district supplied by the anterior cerebral artery is tinted *purple*; middle cerebral, *blue*; posterior cerebral, *red*.

The *cortical branches* emerge between the lips of the stem and posterior ramus of the lateral sulcus, and supply:—(1) the lateral half of the orbital surface (Fig. 172); (2) the temporal pole and the tentorial surface in front of the level of the rhinal notch; (3) a great part of the supero-lateral surface (Fig. 173). It supplies therefore the greater part of the motor centre and of the centre for ordinary sensation (the remainder being supplied by the anterior cerebral), and also the centre for hearing (cf. Figs. 173 and 179).

Dissection.—Remove the blood-vessels and the remains of the arachnoid mater from the base of the brain. The dissection must be done with forceps and a pair of scissors. Very delicate manipulation is necessary, because the cranial nerves, at their points of attachment to the brain, are so intimately connected with the pia mater that any undue traction applied to the membranes will tear the nerves away. Indeed, in the case of the medulla oblongata, the dissector is advised to leave the pia mater in position until the nerve-roots have been studied. The relation of the pia mater to the fourth ventricle also makes this desirable.

When the middle cerebral artery is removed, do not pull its *central branches* out of the brain. Cut them at their origins, and leave them in position. In the final dissection of the cerebrum, they will be encountered as they ascend through the brain substance.

After the vessels and the membranes are removed, the dissectors should begin their more detailed study of the brain by the investigation of the base.

BASE OF THE BRAIN

When the base is examined, a pair of large rope-like strands will be seen issuing from the upper part of the pons. They are the anterior parts of the cerebral peduncles, and each is called a *basis pedunculi*. As they emerge from the pons they are close together, but they diverge as they pass upwards; and, finally, each basis disappears into the corresponding cerebral hemisphere. As it passes into the hemisphere, it is overlapped by the uncus and hippocampal gyrus, and is embraced by *the optic tract*, which is closely applied to the side of the upper end of the basis. The two optic tracts converge as they pass forwards, and, finally, they are joined together by the *optic chiasma*. The chiasma lies at the anterior end of the *interpeduncular fossa*, and below the posterior end of that portion of the longitudinal fissure which intervenes between the orbital surfaces of the brain. The optic nerves enter the antero-lateral angles of the chiasma.

Interpeduncular Fossa.—This is the rhomboidal space bounded by the pons, the cerebral peduncles, and the optic tracts and chiasma. The following parts are situated in the fossa:—(1) the oculomotor nerves; (2) the posterior perforated substance; (3) the mamillary bodies; and (4) the tuber cinereum, with the infundibulum.

Each **oculomotor nerve** issues from the medial side of the corresponding cerebral peduncle, between the basis pedunculi and the tegmentum (p. 379) (Fig. 207).

The **posterior perforated substance** lies in the posterior part of the fossa. It is a layer of grey matter perforated by the central branches of the posterior cerebral arteries (which were pulled away when the pia mater was removed).

The **mamillary bodies** are a pair of small, white, pea-shaped eminences, placed side by side immediately in front of the posterior perforated substance. At a later stage of the dissection, their connexions with the anterior columns of the fornix will be displayed.

The **tuber cinereum** is a slightly raised field of grey matter which occupies the interval bounded by the mamillary bodies and the optic tracts and chiasma. The *infundibulum* springs from the tuber cinereum immediately behind the optic chiasma; it connects the tuber cinereum with the hypophysis, but was cut when the brain was removed.

Anterior Perforated Substance.—The anterior perforated substance is the small triangular district of grey matter that forms the floor of the vallecula of the cerebrum. It is bounded:—posteriorly, by the uncus; anteriorly, by the diverging roots of the olfactory tract; and, medially, by the optic tract (Figs. 174, 189). Laterally, it is continuous with the floor of the lateral sulcus. It is perforated by the central branches of the middle cerebral artery (Figs. 170, 172). The anterior perforated substance is continuous with the *basal nuclei* in the interior of the hemisphere (Fig. 211).

Lamina Terminalis.—The lamina terminalis was originally the end or anterior wall of the brain-tube. It will be displayed if the optic chiasma is pulled gently backwards. It is a thin, grey lamina that passes upwards from the chiasma to become connected with the rostrum of the corpus callosum. It closes the third ventricle anteriorly, and is continuous, on each side, with the anterior perforated substance.

Superficial Attachments of the Cranial Nerves.—Twelve pairs of nerves are attached to the brain. They are numbered and named from before backwards or above downwards, as follows :—

1. Olfactory.
2. Optic.
3. Oculomotor.
4. Trochlear.
5. Trigeminal.
6. Abducent.
7. Facial.
8. Auditory.
9. Glosso-pharyngeal.
10. Vagus.
11. Accessory.
12. Hypoglossal.

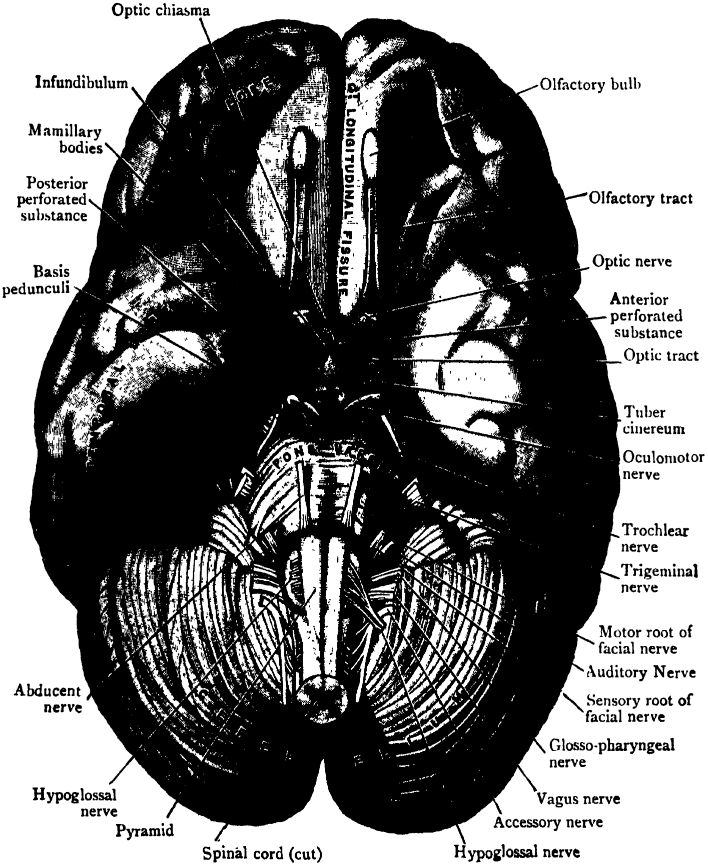

FIG. 174.—Base of Brain with Cranial Nerves attached.

A thirteenth pair, called the *nervi terminales*, is known. Each nervus terminalis is very minute; it is attached to the cerebrum behind the roots of the olfactory tract; its fibres run alongside the olfactory tract, and are distributed with the olfactory nerves. Their functions are unknown.

Each cranial nerve has a superficial attachment and a deep origin or termination. Its *superficial attachment* is the point where its fibres enter or leave the brain surface. The *deep origin* and *deep termination* are the nuclei or clusters of nerve-cells within the substance of the brain in which the efferent or emerging fibres arise and the afferent or entering fibres end. It is the superficial attachments only which come under notice of the dissectors at the present time.

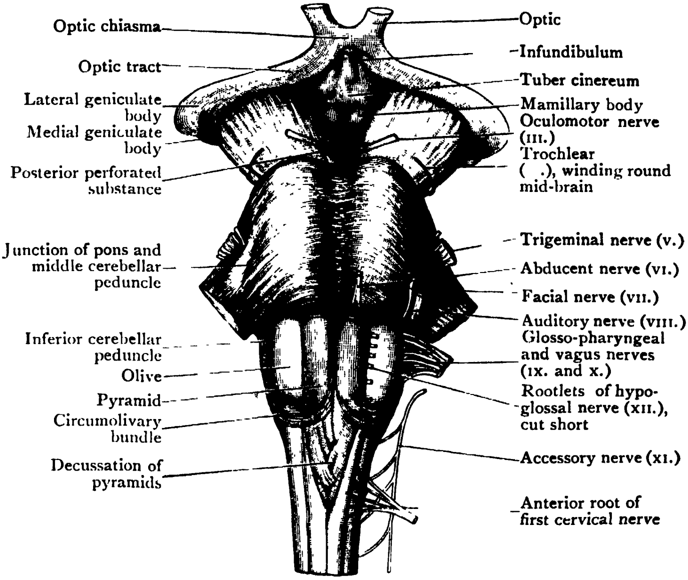

FIG. 175.—Anterior Surface of Brain-Stem of a full-time Fœtus.

No fewer than ten pairs of the cranial nerves—from the third to the twelfth inclusive—have a superficial attachment to the brain-stem, and of these the last eight are attached to the medulla oblongata and the pons—that is to the ventral part of the hind-brain.

The **hypoglossal nerve** is attached by a row of rootlets to the front of the medulla oblongata in the groove between the pyramid and the olive (p. 378). The upper bundles of the *anterior root of the first cervical nerve* are attached to the lower part of the front of the medulla oblongata in the downward continuation of that groove (Fig. 175).

Along the whole length of the side of the medulla oblongata, there is a shallow, narrow groove a little behind the position of the olive. Nerve rootlets are attached, in a long row, to the floor of that groove. They belong to three nerves; but, since these nerve-trunks are divided, it is impossible at present to determine precisely the number of rootlets which belong to each. From below upwards, the nerves are the **accessory**, the **vagus**, and the **glosso-pharyngeal**. The rootlets of the vagus and the glosso-pharyngeal are much more closely crowded together than those of the accessory (Fig. 175).

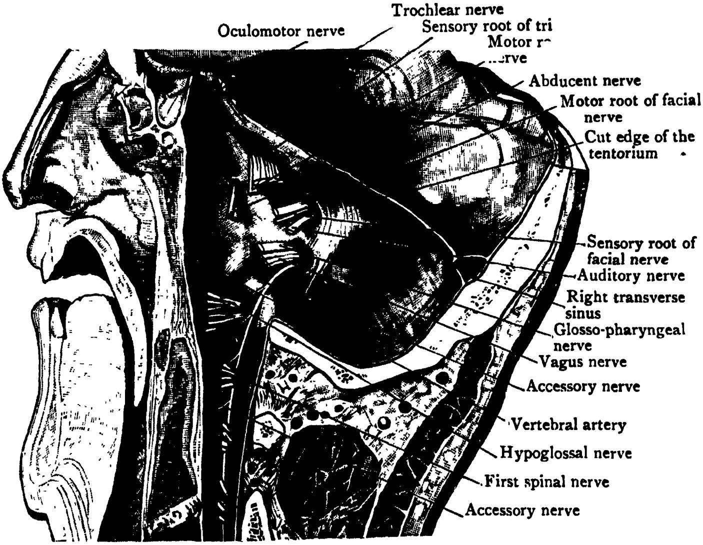

FIG. 176.—Section through Head a little to the right of Median Plane. It shows the posterior cranial fossa and the upper part of the vertebral canal after the removal of brain and spinal cord.

The roots of the accessory which spring from the medulla oblongata constitute only one part of the nerve. The *spinal part* springs from the spinal cord, as low down as the sixth cervical nerve, by a series of rootlets which issue from the side of the cord behind the attachment of the ligamentum denticulatum (p. 82) (Figs. 174, 176).

The **auditory and facial nerves** are attached, close together, at the lower border of the pons immediately above the inferior cerebellar peduncle (p. 378) (Figs. 175, 176).

The *auditory nerve* is the larger of the two, and it lies on the lateral side of the facial. Its two roots embrace the peduncle ; the dorsal root is called the *cochlear nerve*, and the ventral is the *vestibular nerve.*

The *facial nerve* is attached by two roots—a large motor root, and a small sensory root (Figs. 174, 176, 234). The two roots unite in the internal auditory meatus.

The **abducent** emerges through the groove between the lower border of the pons and the lateral part of the pyramid. It is flattened out near its origin and a surface view of it then gives a deceptive idea of its thickness.

The **trigeminal** is the thickest of all the cranial nerves. It is attached to the side of the pons, nearer its upper than its lower border, by two roots—a large sensory root and a small motor root, which are in a line with the facial and auditory nerves. The sensory root is composed of a great number of bundles loosely held together, but the motor root is more compact, and it emerges antero-medial to the point at which the sensory root enters the pons.

The **trochlear nerve** and its superficial origin can be seen when the anterior part of the superior vermis of the cerebellum is displaced backwards. It emerges from the superior medullary velum immediately below the tectum of the mid-brain, and is the only nerve attached to the dorsal surface of the brain-stem. It is a very slender nerve and it has a long intracranial course. In the first part of its course it winds round the side of the mid-brain to reach the interpeduncular region (Figs. 36, 233).

The **oculomotor nerve** issues by several rootlets through the groove on the medial face of the cerebral peduncle in the interpeduncular fossa.

The **optic nerve** is a thick, round nerve which joins the antero-lateral angle of the optic chiasma.

The **olfactory nerves**, about twenty in number on each side, arise in the nasal mucous membrane. They pass into the cranium through the cribriform plate of the ethmoid, and they terminate in the olfactory bulb. It is not probable that the dissectors will find any trace of them on the brain.

THE CEREBRUM

A general outline of the features of the cerebrum was given in the introductory pages 375-390. The dissectors will now examine them in more detail.

Obtain the base of a skull and note the parts of the interior of the skull to which the poles, borders and surfaces of the cerebrum are related, and the parts of the outside of the skull which are opposite certain of them. Refer also to a Head and Neck under dissection and note the relation of the cerebrum to the folds of the dura mater.

Begin by examining the longitudinal fissure, and the poles and borders of the hemisphere. They are defined on pages 382-384.

The **longitudinal fissure**, it was noted before, is complete in front and behind, but is interrupted in the middle by the corpus callosum. It is a very narrow cleft, but is occupied by (1) the falx cerebri, (2) a fold of the arachnoid mater carried into it by the falx, (3) the pia mater covering the medial surfaces of the hemispheres and the upper surface of the corpus callosum, (4) between the arachnoid and the pia, the arteries and veins—chiefly the anterior cerebral vessels, which are close to the corpus callosum. The falx was removed when the brain was taken out of the skull; the other structures are still *in situ*, and should not be disturbed till the medial surface of the hemisphere is examined.

The **frontal pole** is blunt and rounded, and is opposite the root of the nose and the medial part of the superciliary arch. The **occipital pole** is more pointed. It is opposite a spot immediately above and lateral to the external occipital protuberance. If the brain was well hardened *in situ*, the medial side of one or other occipital pole (usually the right) is marked by a wide, shallow, vertical groove made by the terminal part of the superior sagittal sinus. The **temporal pole** also is blunt and rounded, and fits into the recess below the lesser wing of the sphenoid; it is therefore postero-lateral to the orbit.

The **supero-medial border** is the upper margin of the hemisphere; it is convex throughout, and is related to the superior sagittal sinus.

The **infero-lateral border** is convex in its anterior part, which lies along the junction of the squamous and petrous parts of the temporal bone. Its posterior part lies on the transverse sinus, and therefore immediately above the transverse groove of the skull, and is slightly concave. An accentuation of the concavity, about an inch and a half in front of the occipital pole, is called the *pre-occipital notch*; it is produced by a slight bulging of the inner table of the skull; the lower end of the inferior anastomotic vein, or one of the other inferior cerebral veins, lies in it.

The **superciliary border** is a little above the level of the upper margin of the orbit, and is nearly parallel with it.

The **medial orbital margin** is close to its fellow of the opposite side. Its anterior part is wedged in between the crista galli of the ethmoid and the orbital plate of the frontal bone.

In order that the medial occipital and the hippocampal borders may be seen, the hind-brain requires to be removed. If the mid-brain was not divided when the brain was taken out of the skull, make a horizontal section across it, and remove the hind-brain.

The **medial occipital border** is very blunt, and it lies in relation with the straight sinus. The **hippocampal border** is blunt and concave. The posterior cerebral artery will be seen in the gap that separates it from the mid-brain.

The dissectors will now prepare the surfaces of the cerebral hemisphere for examination.

Dissection.—**Remove the membranes and the vessels from the supero-lateral surface of the *left* hemisphere. Begin at the margins of the surface, and reflect the membranes towards the lateral sulcus. When the lips of the sulcus are reached, cut the membranes and the vessels along the lips, and leave the parts inside the sulcus intact at present. As the membranes are pulled away the dissectors should note the general arrangement of the vessels, which come away with the membranes.**

Note the direction of the veins near the margins of the hemisphere (p. 398). Identify the *anastomotic veins* and trace them to the *superficial middle cerebral vein*, which lies between the lips of the lateral sulcus. If the arteries are well injected you will see branches of the *posterior cerebral artery* curving over the infero-lateral margin and the posterior part of the supero-medial margin to gain the supero-lateral surface, and branches of the *anterior cerebral artery* over the anterior part of that margin. Large branches from the *middle cerebral* will be seen issuing from the posterior ramus of the lateral sulcus and spreading over the greater part of the superolateral surface.

Cerebral Gyri and Sulci.—The *sulci* vary in depth. Some are mere surface grooves; some are an inch or more in depth—and there are all degrees between those. And two of them—the calcarine and part of the collateral—are so deep that they produce elevations in the wall of the lateral ventricle. Each *gyrus* has a central core of white matter, and a covering or cortex of grey matter, the thickness of which is determined by its histological structure; and the grey matter of each is continuous with that of its neighbours round the bottoms of the sulci. The grey matter is therefore an unbroken sheet, and by means of the sulci and gyri its surface area is very greatly increased; thus, without addition to its thickness, it maintains its proportion to the amount of the white matter as the bulk of the brain as a whole increases.

The pia mater is the vascular membrane—the "mater" concerned with the nourishment of the cortex—and hence the adjective *pia*. It dips into every sulcus, and opportunity is therefore afforded for the cortical vessels to break up into twigs of exceeding fineness before they enter the substance of the hemisphere. The distribution of the blood to the grey cortex is in that way made uniform.

Supero-Lateral Surface of the Hemisphere.—This surface is convex, to fit the vault of the skull, and its maximum point of convexity underlies the parietal eminence. The surface is most conveniently described if the conventional method of dividing the hemisphere into lobes is adopted; and the student should again examine the sulci that are employed in that division—namely, the lateral sulcus, the central sulcus and the parieto-occipital sulcus.

The **lateral sulcus** has a stem and three rami. The *stem* is the deep, wide, transverse cleft between the temporal pole and the orbital surface. It begins at the vallecula of the cerebrum and ends at the supero-lateral surface by dividing into the three rami. The middle cerebral vessels run in it; and, if the skull is examined, it will be seen that the lesser wing of the sphenoid fits into it, and that its end is opposite the *pterion* of the skull. (*See also* Figs. 187, 195.)

The rami—two anterior and one posterior—radiate from the end of the stem. The *horizontal anterior ramus* is an inch or less in length. It runs forwards a little above the superciliary margin. The *ascending anterior ramus*—about the same length—is a little farther back, and runs upwards and forwards. The two anterior rami often arise by a short common stem; and it is sometimes difficult to identify them.

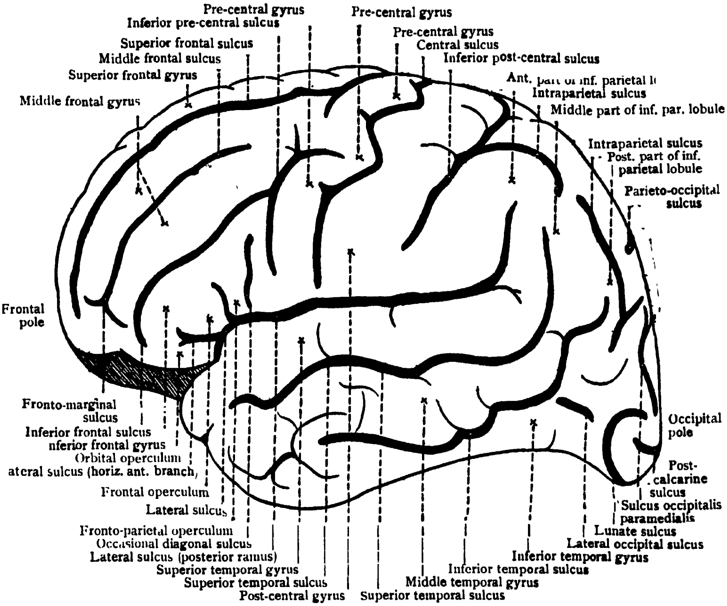

FIG. 177.—Supero-lateral Surface of Left Hemisphere (diagrammatic). The shaded part is the orbital surface.

The *posterior ramus* is much longer and much more important. It runs backwards, with a slight upward inclination, for nearly three inches, and then turns sharply upwards to end at or near the point of maximum convexity of the surface.

The **central sulcus** is about mid-way between the front and the back of the upper part of the surface. The general direction of most of the sulci on this surface is antero-posterior. But, about the middle of the upper part of the surface, there are three whose direction is obliquely downwards and forwards ; the central sulcus is the middle one of those three ; and that, combined with the fact that it is near the middle of the surface, earns it the name " central ". It begins at the supero-medial margin about half an inch behind the mid-way point between the frontal and occipital poles, and usually cuts the margin so that its upper end appears on the medial surface. Its direction at first is usually forwards for a short distance. After that it runs downwards and forwards with sinuous curves that vary greatly in different brains ; and it terminates near the posterior ramus of the lateral sulcus about an inch behind the end of the stem of that sulcus. (*See also* Figs. 187, 195).

The **parieto-occipital sulcus** is on the medial surface, and therefore cannot be fully seen at present. But find its upper end. It is about an inch and a half above the occipital pole, and cuts into the supero-lateral surface for a varying distance —an inch or less. The gyrus which is rolled round its end is called the **arcus parieto-occipitalis.**

LOBES ON THE SUPERO-LATERAL SURFACE.—The *frontal, parietal, occipital* and *temporal lobes* are all seen on the supero-lateral surface ; and, besides these subdivisions, there is the *insula*—sunk out of sight in the lateral sulcus. It must be understood that the areas called the *lobes* of the cerebral hemisphere are defined merely for purposes of description and localisation. They do not correspond with physiological areas (though the central sulcus and the posterior ramus do separate areas of different function), nor do they correspond in extent exactly with the bones after which they are named, for the parietal bone covers not only the parietal lobe but also portions of the other three.

Frontal Lobe.—The frontal lobe is the area in front of the central sulcus, and is therefore much the largest of the lobes. Its boundaries are the central sulcus, the supero-medial and superciliary borders of the hemisphere and the first inch of the posterior ramus of the lateral sulcus.

The chief sulci in the frontal lobe are the pre-central, the superior and inferior frontal and the two anterior rami of the lateral sulcus. The pre-central and frontal sulci divide the surface into the pre-central gyrus and the superior, middle and inferior frontal gyri.

The **pre-central sulcus** is about a finger's breadth in front of the central sulcus, and is nearly parallel to it. It is almost always divided into two parts, named the *superior* and *inferior* *pre-central sulci.* Those two sulci vary greatly in length and shape in different brains. The *superior* and *inferior frontal sulci* begin at or near the pre-central sulci, and run a variable course forwards.

The **pre-central gyrus** is the gyrus between the central and the pre-central sulci, and extends therefore from the superomedial margin to the posterior ramus of the lateral sulcus. It is a very important gyrus, for the **motor area** for the opposite half of the body is lodged in it—in the anterior wall of the central sulcus and the adjoining part of the free surface of the gyrus. The body is, as it were, turned upside down in

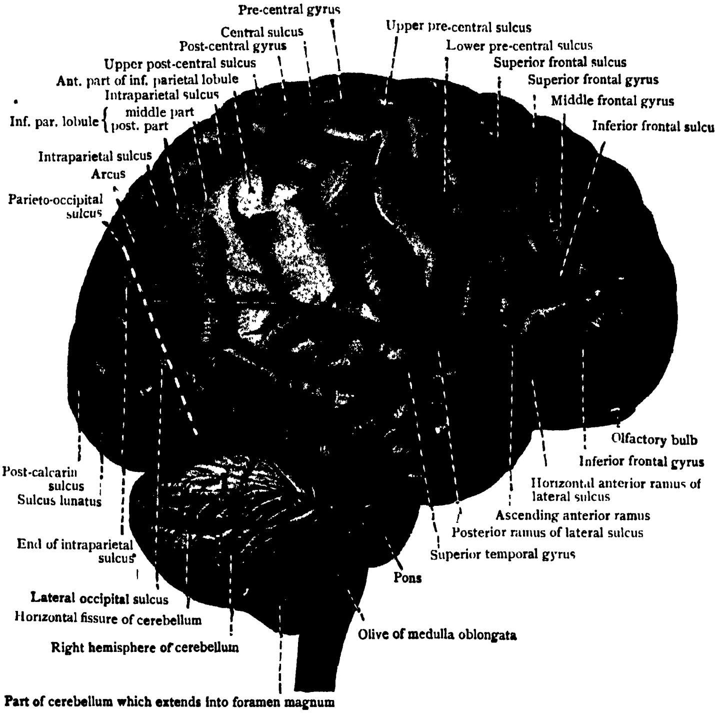

FIG. 178.—Lateral Surface of Right Half of Brain (semi-diagrammatic).

The horizontal dotted line completes the separation between the parietal and temporal lobes, and the oblique dotted line separates the occipital lobe from the parietal and temporal lobes.

the gyrus—head, upper limb, trunk and lower limb from below upwards—and the area for the lower limb flows over the border into the paracentral lobule on the medial surface. The lower two-thirds or three-fourths of the gyrus is supplied by branches of the middle cerebral artery, and the upper third or fourth by the anterior cerebral. It follows that, in an apoplexy resulting from embolism in the middle cerebral artery, the lower limb is less paralysed than the upper.

The remainder of the lobe is divided by the two *frontal sulci* into three areas, named the **superior, middle** and **inferior frontal gyri.**

The two anterior rami of the lateral sulcus cut into the inferior frontal gyrus and divide its postero-inferior part into three parts. In the left hemisphere (in right-handed people), the most posterior of these parts is of special interest, for the **centre for speech** occupies approximately that part of the inferior frontal gyrus and also the adjoining lower part of the pre-central gyrus.

Temporal Lobe.—The temporal lobe is next in size to the frontal lobe. It is bounded by the temporal pole, by the infero-lateral border as far back as the pre-occipital notch, by the lower part of a line drawn from that notch to the upper end of the parieto-occipital sulcus, and, superiorly, it is separated from the frontal and parietal lobes by the horizontal part of the posterior ramus of the lateral sulcus and a line continued backwards from it.

The chief sulci are the superior and inferior temporal. The **superior temporal sulcus** is originally divided into two parts, but, in the adult, it may be one continuous cleft. It is about a finger's breadth below the posterior ramus of the lateral sulcus, and is parallel with it. Therefore, like the posterior ramus, its posterior part bends upwards into the parietal lobe. The **inferior temporal sulcus** is about a finger's breadth below the superior, with which it is more or less parallel, and it bends upwards into the posterior part of the parietal lobe. It is usually broken up into several parts ; and it is often difficult to decide which of the numerous small clefts in this region are to be accounted parts of the inferior temporal sulcus.

Those two sulci divide the surface of the temporal lobe into three strips, named the **superior, middle** and **inferior temporal gyri.**

The **centre for hearing** (Fig. 179) is in the middle of the superior temporal gyrus, both on its free surface and on the adjoining lower wall of the lateral sulcus.

Parietal Lobe.—This lobe is bounded by (1) the superomedial border, (2) the central sulcus, (3) the posterior part of the horizontal part of the posterior ramus and the line projected backwards from it, (4) the upper end of the parieto-occipital sulcus and the upper part of the line that connects the sulcus with the pre-occipital notch.

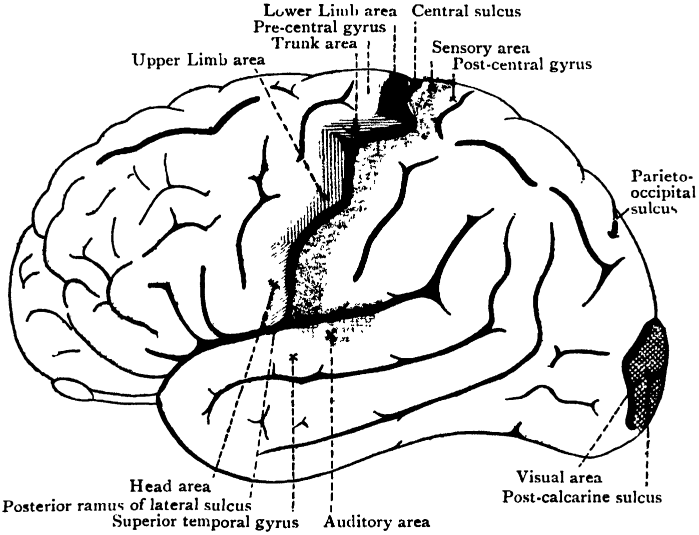

FIG. 179.—Supero-lateral Surface of Left Hemisphere, showing Motor and Sensory Areas. (After Elliot Smith)

The chief sulci of the parietal lobe are the post-central, the intraparietal and the upturned posterior parts of the posterior ramus and the two temporal sulci.

The **post-central sulcus** is nearly parallel with the central sulcus, and about a finger's breadth behind it. The sulcus is developed in separate upper and lower parts; but in the adult they are usually united. The gyrus that separates it from the central sulcus is the **post-central gyrus**. Like the pre-central gyrus, it is an important gyrus, for it contains the

sensory centre for the opposite half of the body. The centre occupies the posterior wall of the central sulcus and the anterior edge of the free surface of the gyrus, and extends over the supero-medial border into the paracentral lobule. As in the motor area, the body is represented upside down ; and the motor and sensory centres for the same part of the body therefore adjoin each other. The arterial supply of the gyrus is like that of the pre-central gyrus.

The **intraparietal sulcus** begins at or near the middle of the post-central sulcus. It runs backwards in the parietal lobe, skirts the arcus parieto-occipitalis, and enters the occipital lobe. As it approaches the occipital lobe, it sends off a branch medially to form the anterior boundary of the arcus ; and it may be interrupted there and start afresh. In the occipital lobe, it soon ends in two widely diverging branches, the medial one of which forms the posterior boundary of the arcus.

The post-central sulcus cuts off the post-central gyrus ; and the intraparietal sulcus divides the rest of the lobe into a **superior parietal lobule** and an **inferior parietal lobule**. The terminal parts of the posterior ramus of the lateral sulcus and the two temporal sulci cut into the inferior parietal lobule, and it is divided into three parts rolled round the ends of these sulci. The *anterior part* (gyrus supramarginalis) surrounds the end of the posterior ramus ; it is the most convex part of the surface of the cerebral hemisphere, and lies under the parietal eminence of the skull. The *middle part* (gyrus angularis) is around the end of the superior temporal sulcus. Those two parts are of interest inasmuch as they contain the centre for the storage of the memory of the meanings of written and printed words. The *posterior part* is around the end of the inferior temporal sulcus, and is separated from the anterior part of the arcus parieto-occipitalis by the intraparietal sulcus. It may, however, be very small ; and it may be difficult to identify it, especially if the inferior temporal sulcus is not clearly marked.

Occipital Lobe.—The occipital lobe is the smallest of the lobes, and forms the pointed, posterior part of the hemisphere, behind the parieto-occipital sulcus. On the supero-lateral surface, it is bounded by the posterior parts of the supero-medial and infero-lateral borders, and by the line drawn from the parieto-occipital sulcus to the pre-occipital notch.

On this surface, the sulci and gyri are very inconstant. If the post-calcarine sulcus extends into this surface it carries a part of the **centre for sight** with it, and the centre is then bounded by a curved sulcus called the *sulcus lunatus* (the dark line limiting the "visual area" in Fig. 179).

Inferior Surface of Hemisphere.—The dissectors will now examine the inferior surface, which is uneven, and is divided by the stem of the lateral sulcus into the *orbital surface* in front and the *tentorial surface* behind. Remove the membranes, and look for the blood-vessels at the same time.

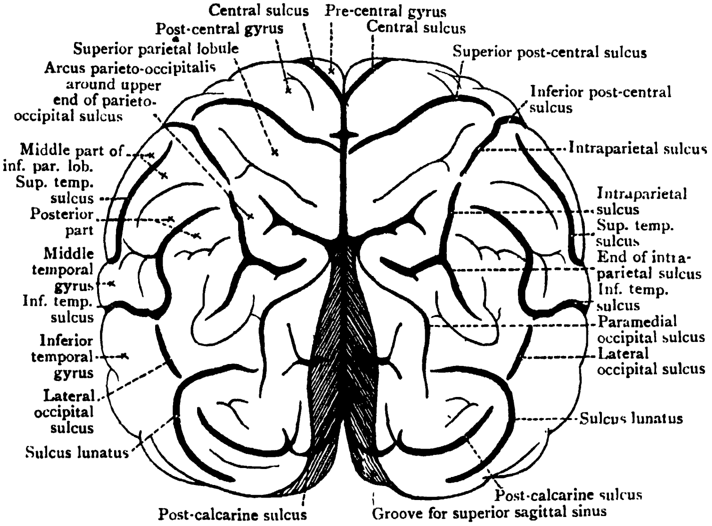

FIG. 180.—Posterior View of Cerebral Hemispheres (diagrammatic)

The posterior parts of the supero-medial borders are separated and portions of the medial surfaces are seen (shaded).

The *superficial middle cerebral vein*, which lies between the lips of the lateral sulcus and ends in the cavernous sinus, has probably been removed; but the *deep middle cerebral vein* may still be present, as it lies more deeply in the sulcus. The *anterior cerebral vein* will be found grooving the posterior part of the medial orbital margin above the chiasma; it runs backwards and laterally to join the deep middle vein in the vallecula to form the *basal vein*, which curves backwards round the side of the mid-brain; and one or other of those veins—the deep or the anterior or the basal—is joined by the *striate vein* (or *veins*), which descends through the anterior part of the anterior perforated substance.

If the arteries are well injected, branches of all three cerebral arteries will be found. Branches from the *anterior cerebral arterv* will be seen curving over the medial orbital margin to supply the medial half of the orbital surface. Note the small branches of the *middle cerebral artery* that (1) run forwards into the lateral half of the orbital surface, and (2) curve downwards to supply the temporal pole and the small part of the tentorial surface that is in front of the level of the uncus. A part of the posterior cerebral artery will be seen curving backwards in the gap between the hippocampal margin and the mid-brain, and disappearing into the calcarine sulcus; and large branches which it sends to supply nearly the whole of the tentorial surface will be seen spreading over that surface and curving round the infero-lateral margin to supply the lower part of the occipital lobe and the inferior temporal gyrus.

Orbital Surface.—The orbital surface is slightly concave and looks slightly in a lateral direction as well as downwards, and is therefore partly seen from the lateral side (Fig. 178).

It rests chiefly on the roof of the orbit, but also on the roof of the ethmoidal sinuses, the roof of the nose, and the roof of the anterior part of the sphenoidal sinus. It is bounded by the superciliary and medial orbital margins, and by the vallecula and the stem of the lateral sulcus.

The most constant groove in the orbital surface is the **olfactory sulcus.** It is near the medial orbital margin, with which it is almost parallel; and the olfactory tract and bulb lie in it. The strip between the olfactory sulcus and the medial orbital border is the lower surface of the **gyrus rectus,** which forms also the part of the medial surface immediately above the medial orbital border. It lies behind on the roof of the sphenoidal sinus; and its narrowest part, medial to the olfactory bulb, lies in the angle between the crista galli and the cribriform plate.

The remainder of the orbital surface is divided by irregular, inconstant **orbital sulci** into **orbital gyri.** When the larger sulci make an H-shaped figure, they divide the surface into anterior, posterior, lateral and medial orbital gyri.

The **olfactory bulb** is a narrow, oval body about three-quarters of an inch in length. It lies obliquely on the surface of the gyrus rectus with its lateral border in the olfactory sulcus. It receives the filaments of the olfactory nerve—about twenty in number—which ascend from the olfactory part of the mucous membrane of the nose through the cribriform plate, on which it rests.

The **olfactory tract** is a slender, three-sided, white band continued backwards from the bulb (Figs. 181, 189). It lies in the olfactory sulcus and on the roof of the sphenoidal sinus. It ends at the anterior margin of the anterior perforated substance by joining a three-sided, grey elevation called the *olfactory pyramid*. As it joins the pyramid, it sends off two diverging bands called its roots. The *medial root* is an ill-defined strand that curves medially in the posterior end of the gyrus rectus to reach the medial surface, where it disappears in the grey matter. The *lateral root* first runs in a lateral direction and backwards along the margin of the anterior perforated substance, and then curves backwards across the floor of the stem of the lateral sulcus close to the insula, and ends in the uncus. It is easily seen in the first part of its course but less distinctly in the second part.

Tentorial Surface.—The tentorial surface is much larger than the orbital surface. In the greater part of its extent it is markedly concave from before backwards ; and it looks medially as well as downwards, so that a great part of it can be seen from the medial side. It extends from the temporal pole to the occipital pole ; it is bounded laterally by the infero-lateral border, and medially by the hippocampal and medial occipital borders.

The posterior part of the concave portion rests upon the tentorium cerebelli, which gives the name to the surface. The anterior part of this concave portion rests on the anterior face of the petrous temporal bone. It therefore overlies the middle ear, the internal ear and the carotid canal ; and the arcuate eminence produced by the superior semicircular canal of the internal ear makes a shallow pit on the surface, called the *petrous impression*, which can be seen at a glance in a brain that has been well-hardened *in situ*. The trigeminal ganglion, in its cave of dura mater, intervenes between the surface and the petrous temporal bone near its apex. The portion of the surface behind the temporal pole is convex, and rests upon the anterior part of the floor of the middle cranial fossa, which separates it from the infratemporal fossa.

The chief sulci of the tentorial surface are the rhinal, the collateral, the occipito-temporal, and the anterior part of the calcarine.

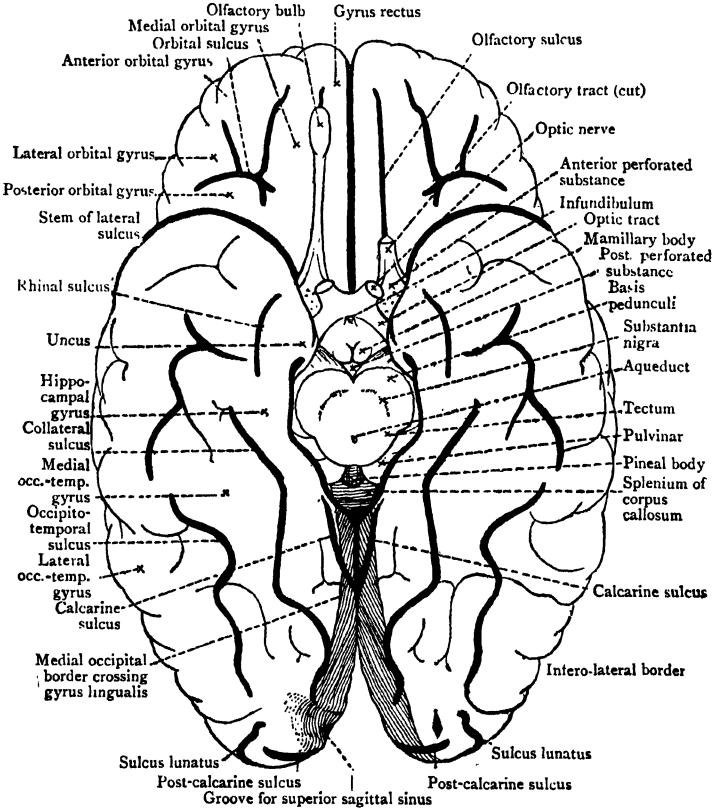

FIG. 181.—Inferior Surface of Hemispheres (diagrammatic).

The **rhinal sulcus** is very variable and may be continuous with the collateral sulcus. When present as a separate sulcus, it begins at or near the notch between the uncus and the temporal pole and extends backwards for a short distance. The

collateral sulcus is usually the best marked of the sulci on the tentorial surface. It begins at or near the rhinal sulcus and extends to the occipital pole. It may be one continuous furrow or divided into two or three parts. Its middle part is so deep that it makes an elevation, called the *collateral eminence*, in the floor of the inferior horn of the lateral ventricle.

It is more difficult to identify the **occipito-temporal sulcus,** for it is usually broken up into parts, and these parts do not always lie end to end. The sulcus, as a whole, is about a finger's breadth lateral to the collateral sulcus, and extends from the occipital pole to the temporal pole.

The main part of the **calcarine sulcus** is on the medial surface, but its anterior part cuts across the medial occipital border near the splenium of the corpus callosum, and appears for a short distance on the tentorial surface.

The gyri on the tentorial surface are the lateral and medial occipito-temporal, the hippocampal, the uncus, the isthmus of the gyrus cinguli and part of the lingual gyrus.

The **lateral occipito-temporal gyrus** is the irregular strip between the occipito-temporal sulcus and the infero-lateral border. The **medial occipito-temporal gyrus** (gyrus fusiformis) is the long gyrus between the occipito-temporal and collateral sulci.

The **lingual gyrus** is the wide area that separates the calcarine and post-calcarine sulci from the posterior part of the collateral sulcus ; it is, therefore, partly on the tentorial surface and partly on the medial surface.

The **isthmus of the gyrus cinguli** is the short, narrow strip between the splenium and the anterior part of the calcarine sulcus ; it connects the hippocampal gyrus with the gyrus cinguli, which will be seen when the medial surface is examined.

The isthmus and the lingual gyrus end at the level of the anterior extremity of the calcarine sulcus, where both of them are directly continuous with the hippocampal gyrus.

The **hippocampal gyrus** is the strip which is medial to the anterior part of the collateral sulcus ; it is the most important gyrus on the tentorial surface, for it is continuous with the uncus and is closely associated also with other structures—hippocampus and dentate gyrus—which, like the uncus, are concerned with the **sense of smell**; and there is evidence that it itself may contain the **centre for taste**, which is closely allied to the sense of smell.

The **uncus** is the area—about an inch in extent—that is continuous with the anterior end of the hippocampal gyrus. Laterally, it is bounded by the rhinal sulcus and notch, anteriorly, it has a free, oblique border that overlaps and bounds the vallecula. Medially, the uncus overlaps and conceals part of the optic tract and the basis pedunculi of the mid-brain. It receives the name "uncus" because a narrow cleft runs into its medial part from behind and gives it a resemblance to a hook. Find that cleft, open it up, identify the smaller, medial part of the uncus, and note an indistinct, narrow ridge that crosses that portion transversely; that ridge is the *tail of the dentate gyrus*—a gyrus which will be partly exposed when the inferior horn of the lateral ventricle is opened (p. 450). The surface of the uncus is distinguished from the rest of the cortex by a peculiar whitish, warty appearance.

Opercula of the Insula.—The opercula are the parts of the hemisphere that overlap and conceal the insula. They form, therefore, the boundaries of the lateral sulcus, and are separated from one another by its stem and rami. There are four of them—named orbital, frontal, fronto-parietal and temporal. The *orbital operculum* is the part of the cortex between the stem and the horizontal anterior ramus; it overlaps the insula from below and in front. The *frontal operculum* lies between the two anterior rami, and overlaps the insula from above and in front. The *fronto-parietal operculum* overlaps the insula from above; it lies above the posterior ramus and behind the ascending anterior ramus; the central sulcus descends into it, and it belongs therefore to both the frontal lobe and the parietal lobe. The *temporal operculum* is bounded by the stem and the posterior ramus; it overlaps the insula from below and behind.

Dissection.—**Open the lateral sulcus by separating the opercula from one another. Remove the membranes and the vessels from the deep surfaces of the opercula and from the insula. If the brain is fairly pliable, pulling the opercula apart will expose the *insula* sufficiently for study; but, in a well-hardened brain, it is necessary to remove the opercula. Do so by cutting through their roots, and try to remove each of them in one piece in order that they may be easily replaced.**

Insula.—The insula is a portion of the cortex submerged in the lateral sulcus. It is a pyramidal elevation with three unequal sides. The *base* is separated from the roots of the opercula by a groove which, though triangular in outline, is called the *circular sulcus*. The *apex* is at the antero-inferior part of the pyramid, and is connected with the anterior perforated substance by a low, smooth ridge called the *limen insulæ*. The surface of the insula is divided into several small gyri.

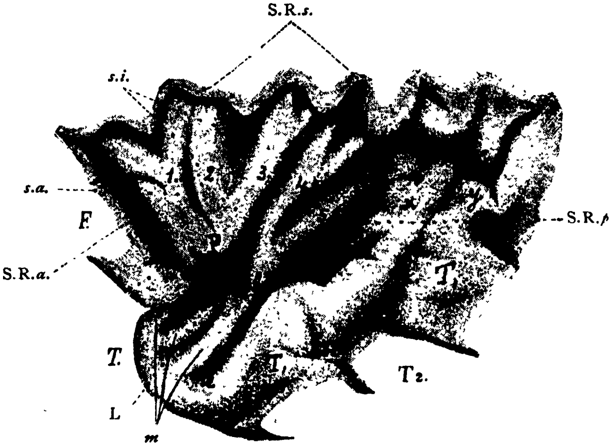

FIG. 182.—Sulci and Gyri of the Insula (Eberstaller).

1, 2, and 3. Three short gyri on the frontal part of the insula.
4 and 5. Two long gyri on parietal part.
S.R.*a*. Anterior part of circular sulcus.
S.R.*s*. Superior part of circular sulcus.
S.R.*p*. Inferior part of circular sulcus.
L. Limen insulæ.
P. Apex of the insula.
F. Orbital operculum (for the most part removed).

T. Temporal pole.
T1. Superior temporal gyrus.
T2. Middle temporal gyrus.
x.y. Transverse temporal gyri on the insular surface of operculum.
s.i. Central sulcus of insula.
s.a. Pre-central sulcus of insula.
m. Gyri on deep surface of temporal pole.

☞ **Fasciculus Uncinatus** (Fig. 218).—The grey matter of the limen insulæ is very thin. If it is scraped away, a round bundle of slightly twisted fibres will be disclosed. It hooks round the bottom of the lateral sulcus, and is therefore called the *fasciculus uncinatus*. Its ends fan out into the lower part of the frontal lobe and the anterior part of the temporal lobe; and it consists of *long association fibres* (p. 431) which connect the cortex of those two parts of the brain.

The dissectors will now proceed to the study of the medial surface of the hemisphere. To expose the medial surface of the right hemisphere they require to remove the upper part of the left. In the process of doing so, they must try to isolate a large, longitudinal bundle of fibres, called the *cingulum*, which lies on the corpus callosum; and they will clean the upper surface and the ends of the left half of the corpus callosum, and will examine the white matter of the cerebrum.

Dissection.—Identify the sulcus cinguli on a cast or on a specimen in which the medial surface is exposed, and then ascertain the position of that sulcus on your own specimen. With a long brain-knife, slice off the upper part of the *left* hemisphere down to the level of the sulcus cinguli. It may be removed by one bold slice; but it is safer to use more than one, to avoid injury to the corpus callosum, for the corpus callosum inclines upwards after it enters the hemisphere. Cleaner cuts will be made if the knife is moistened.

When the sulcus cinguli is reached, abandon the large knife, and with the handle of a scalpel scrape away the grey matter of the lower wall of the sulcus cinguli and of the medial side of the gyrus cinguli. That will expose the *cingulum*—a long white bundle about the thickness of a pencil—which lies in the gyrus cinguli. Trace the cingulum backwards and forwards till it bends downwards round the splenium and the genu of the corpus callosum. Sheets of fibres will be found spreading from its lateral side into the adjoining white matter. Cut through them cautiously with the *handle* of the scalpel; pass the handle, or a blunt hook, under the cingulum and gently isolate it from the corpus callosum, but do not remove it.

Pass now to the *genu*. Trace its fibres as they curve forwards into the left frontal lobe, removing the gyri with the handle of the scalpel. Trace the fibres of the splenium in like manner as they sweep backwards into the posterior part of the hemisphere.

White Matter of Cerebrum.—The dissectors will leave the cingulum and corpus callosum for study at a later period, and will now examine the cut surface of the left hemisphere. The cut white matter is studded sparsely with little holes; these are cut blood-vessels, and, in many cases, droplets of blood are seen in them. The nerve-fibres in the white matter are placed in three classes according to their connexions—association fibres, commissural fibres, and itinerant or projection fibres. These fibres are mingled with one another, and are all glued together with neuroglia into one white mass. (The word *glia* means glue.)

Association Fibres.—These are fibres that connect the gyri of the same hemisphere. Note the construction of the gyri: a white core and a grey cortex. Scrape away some of the white matter below the bottom of a sulcus. If the brain is in good condition, bundles or sheets of fibres will be seen curving round the bottom of the sulcus from one gyrus to another. These are called **short association fibres**; they connect the grey matter of a gyrus with the grey matter of its immediate neighbours. Each gyrus is connected also with the gyri farther afield by **long association fibres,** which are grouped into long bundles; the cingulum is one of these bundles and the fasciculus uncinatus (p. 429) is another; the others are more deeply placed, and will be dissected later (p. 488). By means of the association fibres, each gyrus is connected with a very large number of other gyri in the same hemisphere—possibly with all of them. The bulk of the white matter of the hemisphere consists of association fibres.

Commissural Fibres.—The commissural fibres connect the gyri of one hemisphere with the gyri of the other. They pass from the gyri into the white centre, and, in crossing to the opposite side, nearly all of them are in the corpus callosum; the remainder cross in the anterior commissure. These two structures consist wholly of commissural fibres and neuroglia.

Itinerant Fibres.—The itinerant or projection fibres are those that connect the gyri with the parts beneath—thalamus, basal nuclei, brain stem and spinal cord. Some of them pass from the gyri to these parts, and some pass from the thalamus and the basal nuclei to the gyri; and the longest fibres in the central nervous system are the itinerant fibres that descend from the motor area of the cortex to the lower part of the spinal cord. Some of the parts that have been seen or mentioned already are composed of itinerant fibres (and neuroglia)—*e.g.*, internal capsule (p. 380), basis pedunculi, pyramid of medulla oblongata. The internal capsule is continuous superiorly with the *corona radiata*, which consists of multitudes of itinerant fibres that (1) radiate from the internal capsule to all parts of the cortex, and (2) converge upon the capsule from the cortex.

The dissectors will now clean the medial surface of the right hemisphere.

Dissection.—**Find the *right anterior cerebral artery* at the genu. Trace it and its branches first downwards towards its origin, removing, if necessary, more of the anterior part of the left hemisphere, and then backwards above the corpus callosum. Look for the *anterior cerebral vein* at the same time. Then, find the *posterior cerebral artery* as it enters the calcarine sulcus, and trace its branches.**

The anterior and posterior cerebral arteries are described on pages 404, 405. These pages should be read again. When that has been done, remove the membranes and the vessels from the medial surface of the right hemisphere.

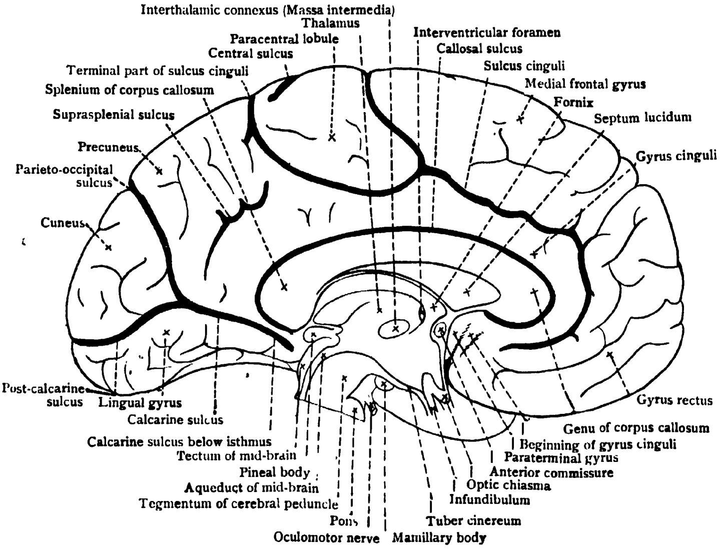

FIG. 183.—Medial Surface of Left Hemisphere (diagrammatic).

Medial Surface of Cerebral Hemisphere.—The cortical part of this surface is limited superiorly by the supero-medial border, and inferiorly by the corpus callosum and the medial occipital and medial orbital borders. It is the flat, vertical boundary of the longitudinal fissure. The greater part of it is separated from the other hemisphere by the falx cerebri; but, near the anterior end, the lower part is separated only by the pia-arachnoid, and the two hemispheres are so close together that their gyri may interlock.

The chief sulci are the sulcus cinguli, the suprasplenial, callosal, parieto-occipital, calcarine and post-calcarine sulci; and the upper end of the central sulcus very often cuts into it for a short distance.

The **callosal sulcus** is the slit that runs round the convex outline of the corpus callosum, separating it from the cortex.

The **sulcus cinguli** is parallel with the callosal sulcus, and is about a finger's breadth distant from it. It begins below the anterior part of the corpus callosum, arches upwards in front of the genu, and then runs backwards almost as far as the splenium; lastly, it bends sharply upwards to end at the supero-medial margin, immediately behind the upper end of the central sulcus, to which it may serve as a guide.

The **suprasplenial sulcus** (sulcus subparietalis) is a short groove situated above and behind the splenium, more or less in line with the horizontal part of the sulcus cinguli; it is, however, variable in shape and position, and may be continuous with other sulci.

The **calcarine sulcus** is very constant, and is so deep that it produces an elevation called the *calcar avis* on the medial wall of the posterior horn of the lateral ventricle. (The calcar derives its name from its resemblance to the spur of a cock, and the sulcus is named after it.) The sulcus begins on the tentorial surface a little below the splenium of the corpus callosum, passes backwards and upwards on to the medial surface, becoming deeper as it runs, and joins the lower end of the parieto-occipital sulcus. It is then continued downwards and backwards as the **post-calcarine sulcus**, the change of name being accounted for by the fact that the two parts are developed independently. The post-calcarine sulcus may end on the medial surface near the occipital pole, or it may turn round the margin and run for a short distance into the supero-lateral surface.

The **centre for sight** is closely related to these sulci. It occupies the area immediately below the calcarine sulcus, and the areas immediately above and below the post-calcarine and around its end. The visual centre is peculiar in that the grey matter is divided into two layers by a thin white layer visible to the naked eye as a thin white line in a section. This line is called the *visual stria*; and the visual area is sometimes called the **striate area**.

The **parieto-occipital sulcus** also is a deep, constant cleft.

It extends from the calcarine sulcus upwards to the supero-medial margin about an inch and a half above the occipital pole ; and its upper end has been seen already on the supero-lateral surface.

In contrast with the supero-lateral surface, the medial surface is simple in the arrangement of its principal gyri, and they are easily identified They are :—

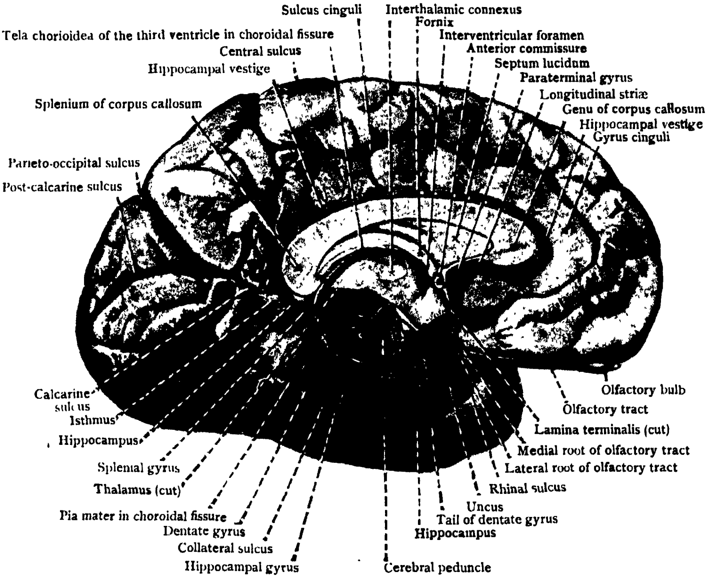

FIG. 184.—Medial aspect of Left Hemisphere showing portions of the Rhinencephalon and associated parts.

The lingual gyrus
The cuneus
The precuneus
The gyrus cinguli and its isthmus
The paraterminal gyrus
The gyrus rectus
The medial frontal gyrus (including the paracentral lobule)

The **gyrus lingualis** is the area below the calcarine and post-calcarine sulci. It separates them from the posterior part of the collateral sulcus, and forms part of the tentorial surface as well as of the medial surface. It contains a considerable part of the centre for sight.

The **cuneus** is the wedge enclosed by the post-calcarine and parieto-occipital sulci and the supero-medial margin. It also contains a part of the centre for sight.

The **precuneus** is the quadrate area in front of the cuneus, and is bounded by the parieto-occipital sulcus, the supero-medial margin, the upturned part of the sulcus cinguli, and the suprasplenial sulcus.

The **gyrus cinguli** is the long strip that separates the callosal sulcus from the sulcus cinguli and the suprasplenial sulcus. Posteriorly, it is continuous with the *isthmus*, which is the narrow band of cortex that separates the splenium from the calcarine sulcus and connects the gyrus cinguli with the hippocampal gyrus.

The **paraterminal gyrus** is little more than half an inch long and is very narrow. It lies along the edge of the lamina terminalis and the rostrum of the corpus callosum, and is marked off from the gyrus cinguli by a short, shallow furrow.

The **gyrus rectus**, whose lower surface has been seen already on the orbital surface, is the horizontal strip immediately above the medial orbital margin; it may be very imperfectly marked off from the medial frontal gyrus.

The **medial frontal gyrus** (marginal gyrus) is all the rest of the area between the sulcus cinguli and the margins of the hemisphere, and is both long and wide.

Its posterior part—an inch or more in extent—is partly or wholly cut off by a branch of the sulcus cinguli, and is called the **paracentral lobule.** It receives this name because the central sulcus cuts it; and it is continuous with the upper ends of the pre-central and post-central gyri. The motor and sensory areas for the lower part of the lower limb of the opposite side are in its upper part.

The dissectors will now turn to the left hemisphere and examine the cingulum, and will then study the corpus callosum.

Cingulum.—The cingulum is a thick bundle of long association fibres (Figs. 188, 200). Throughout its whole course it therefore gives off fibres to the adjacent grey matter and receives fibres from it. It runs most of its course in the substance of the gyrus cinguli, on the surface of the corpus callosum; but, in its whole extent, it forms an almost complete circle (*cingulum* means a *girdle*). It begins at the anterior perforated substance, enters the gyrus cinguli, and, in that gyrus, it arches round the genu and runs backwards on the trunk of the corpus callosum to the splenium; it then passes through the isthmus into the hippocampal gyrus, and runs onwards to the uncus (which adjoins the anterior perforated substance).

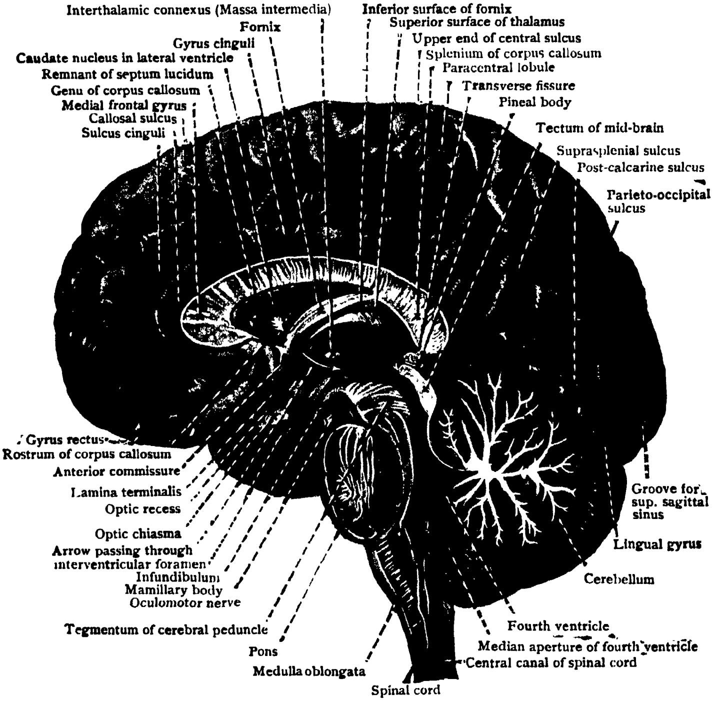

FIG. 185.—Median Section of Brain. The Septum Lucidum has been removed. The arrow passes through the Interventricular Foramen, and lies in the Hypothalamic Sulcus.

***Dissection*.—Remove the cingulum, and trace the fibres of the upper surface of the left half of the corpus callosum laterally into the white centre of the hemisphere.**

The dissectors may expose the right half also of the corpus callosum in order to obtain a more complete view of it; but,

PLATE XIII

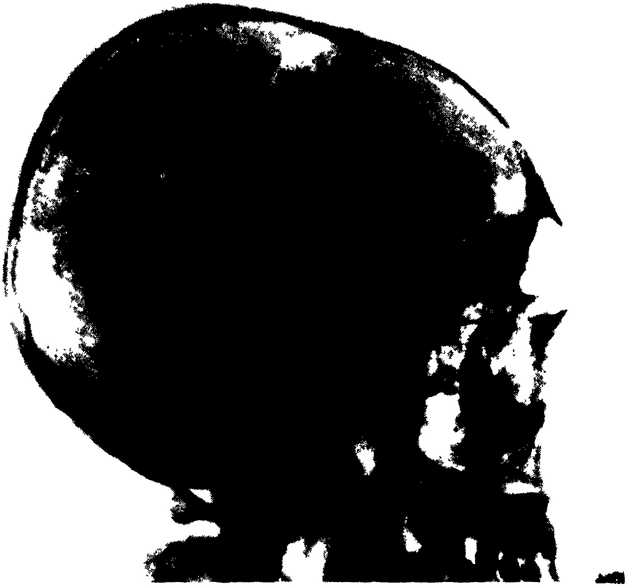

FIG. 186.—Lateral Radiograph of Head of man aged 24 (from a positive print) after injection of thorium dioxide (thorotrast) into the right internal carotid artery (Cerebral Arteriograph: Mr. Norman M. Dott. From Beesly and Johnston's *Manual of Surgical Anatomy*.)

The Internal Carotid Artery is seen in the upper part of the neck, in the carotid canal, and in the cavernous sinus. Note its division into Anterior and Middle Cerebral Arteries and the appearance of their branches. The Ophthalmic Artery also is seen leaving the internal carotid and ramifying in the orbit.

[*Facing p.* 436

PLATE XIV

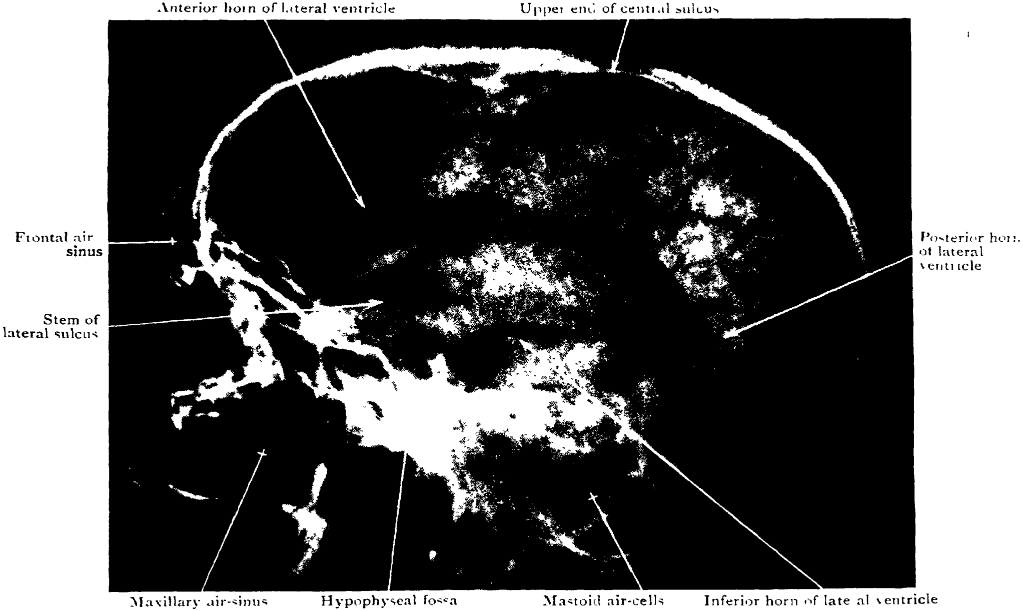
Anterior horn of lateral ventricle
Upper end of central sulcus
Frontal air sinus
Stem of lateral sulcus
Posterior horn of lateral ventricle
Maxillary air-sinus
Hypophyseal fossa
Mastoid air-cells
Inferior horn of lateral ventricle

FIG. 187.—Lateral Radiograph of Head of man aged 24, after injection of oxygen into the spinal subarachnoid space by lumbar puncture (Encephalograph: Mr. Norman M. Dott). The sulci of the Cerebral Hemisphere appear in the radiograph on account of the relative translucency to the X-rays of the oxygen-filled subarachnoid spaces. The oxygen has entered the ventricular system also, and the form, size and position of a Lateral Ventricle are well shown. Cf. Fig. 194.

unless they have two specimens of brain at their disposal, or foresee an early opportunity of dissecting another brain, they should retain the right half intact as long as possible for purposes of revision.

If they choose to dissect the right half now, they should not slice off the upper part of the hemisphere, but tear it off piecemeal. That method gives them a better idea of the fibrous character of the white matter, and of the manner in which the fibres of the corpus callosum enter the gyri.

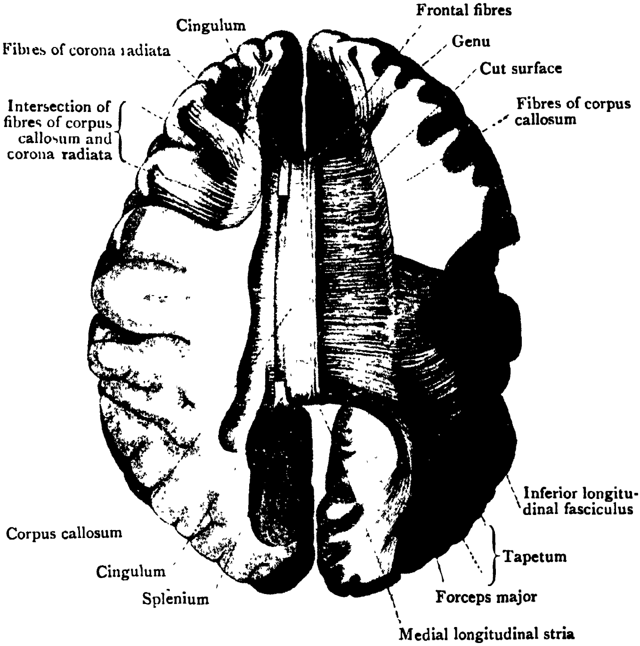
Cingulum
Fibres of corona radiata
Intersection of fibres of corpus callosum and corona radiata
Frontal fibres
Genu
Cut surface
Fibres of corpus callosum
Inferior longitudinal fasciculus
Tapetum
Forceps major
Medial longitudinal stria
Corpus callosum
Cingulum
Splenium

FIG. 188.—Corpus Callosum exposed from above and the right half dissected to show the course taken by the fibres.

CORPUS CALLOSUM

Only a partial view of the corpus callosum and its connexions can be obtained at the present stage. That can be partly remedied if the student obtains the half of a brain (or a cast), which will enable him to see the corpus callosum in median section. Coronal sections of his own specimen will be made later.

The **corpus callosum** is the chief commissure of the cerebrum. It is placed nearer the anterior than the posterior end of the brain, and it unites the medial surfaces of the two cerebral hemispheres throughout very nearly a half of their antero-posterior length (Fig. 185).

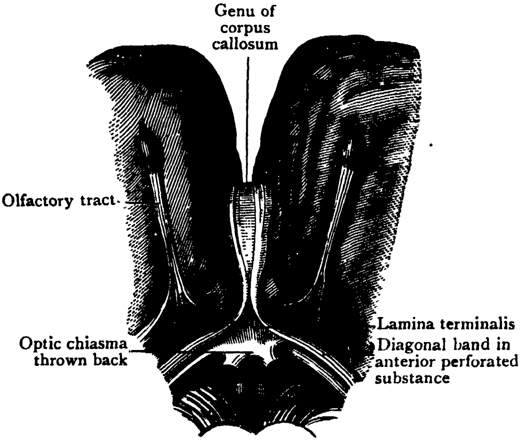
Genu of corpus callosum
Olfactory tract
Optic chiasma thrown back
Lamina terminalis
Diagonal band in anterior perforated substance

FIG. 189.—Anterior end of Corpus Callosum and Longitudinal Striæ as seen from below when the frontal lobes of the hemispheres are slightly separated from each other. (From Cruveilhier)

Relations.—The corpus callosum roofs over the central part and anterior horn of each lateral ventricle, and its *lower surface* is therefore coated with the ependyma of the ventricle. But in the median line, between the two ventricles, the septum lucidum is attached to it and connects it with the fornix.

Its *upper surface*, which forms the floor of the middle part of the longitudinal fissure, is convex antero-posteriorly and concave from side to side. The anterior cerebral vessels lie between the arachnoid and pia mater which cover it. At its posterior end it is touched, in the median plane, by the falx cerebri; anteriorly, that fold of dura mater does not pass so deeply into the fissure. On each side of the fissure, the corpus callosum is covered by the gyrus cinguli.

The upper surface of the corpus callosum is coated with a layer of grey matter, called the *indusium griseum*, which is so thin that the white fibres can be seen through it. At the bottom of the callosal sulcus, it is continuous with the cortex of the hemisphere. Two pairs of delicate longitudinal bands of fibres called the *lateral* and *medial longitudinal striæ* are embedded in the indusium. The medial stria is the more strongly marked of the two, and lies close to the median plane. The lateral stria is under cover of the gyrus cinguli. These are vestigial structures that belong to the part of the brain concerned with the **sense of smell.** Posteriorly, they are continuous, round the splenium, with the splenial gyrus and the hippocampus, both of which will be examined when the inferior horn of the lateral ventricle is opened. Anteriorly, they are connected (1) with the paraterminal gyrus and (2) with the temporal lobe near the uncus by means of a " diagonal band " which runs in a lateral direction across the posterior part of the anterior perforated substance (Fig. 189).

Subdivisions and Connexions.—The main part of the corpus callosum is called the *trunk*, and is thinner than the two extremities (Fig 185). The posterior end, which is full and rounded, lies over the mid-brain, and extends backwards as far as the highest point of the cerebellum It is called the *splenium.* The anterior end is folded downwards and backwards, and is termed the *genu.* Its recurved, lower portion rapidly thins as it passes backwards, and is called the *rostrum.* The fine, terminal edge of the rostrum is attached by neuroglia to the lamina terminalis on the front of the anterior commissure (Fig 185).

The fibres of the corpus callosum, as they enter the white centre of the hemisphere, radiate towards the various parts of the cortex. The fibres of the genu sweep forwards in a series of curves towards the frontal pole. The arch formed by the genu and these curving bundles on the two sides is called the **forceps minor.** The splenium breaks into curving bundles that pass into the precuneus, the cuneus and the lingual gyrus. Of these bundles, the one which is found and traced most easily in an ordinary dissection is that which passes into the cuneus. The splenium and the right and left cuneal bundles form a wide arch called the **forceps major.** As the fibres of the main part of the trunk pass into the white centre they *intersect* the fibres of the corona radiata ; but some fibres of the posterior part of the trunk and of the splenium pass into the white centre as a non-intersecting sheet called the **tapetum.** The tapetum spreads out into a thin layer to form the roof and lateral wall of the posterior horn of the lateral ventricle and the lateral wall of the inferior horn (Fig. 188).

LATERAL VENTRICLE

The left lateral ventricle should now be opened up.

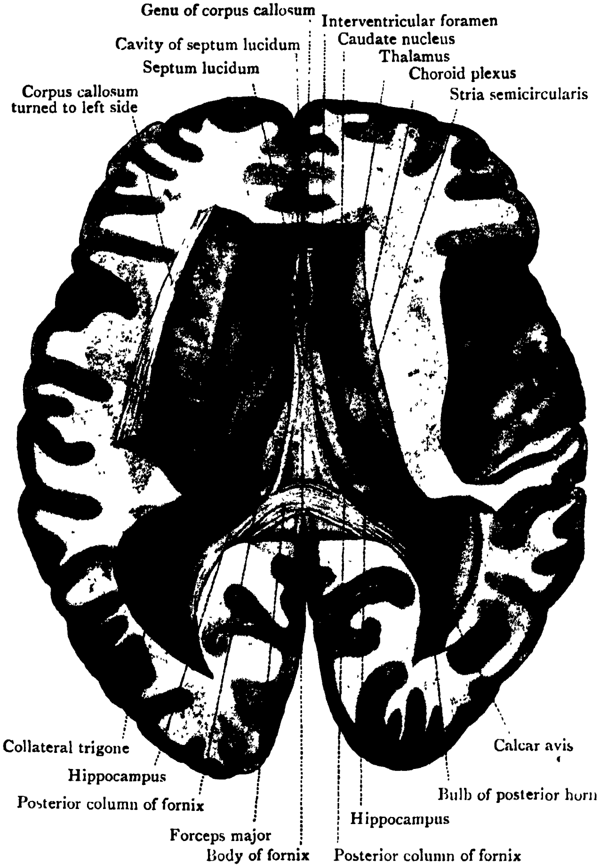

FIG. 190.—Dissection to show Lateral Ventricles. ½

Dissection.—**Make a sagittal incision through the corpus callosum, about *a quarter of an inch* or less to the left of the median plane, and cross-cuts near the genu and the splenium. Turn the flap aside, and then remove it. If the dissectors have exposed both halves of the corpus callosum, they may do this on both sides.**

The central part and the anterior horn of the ventricle are

now exposed. To open the posterior horn, carry the knife backwards through the white matter which forms the roof of the left horn, and remove a sufficient amount of the roof to give a complete view of its interior. Greater difficulty will be experienced in opening up the inferior horn. Place the point of the knife in the upper part of the horn, where it joins the central part of the ventricle, and carry the blade forwards and downwards, through the lateral part of the temporal lobe, towards the temporal pole, following the course of the cavity, which corresponds, very nearly, with the course of the superior temporal sulcus. The lateral wall of the inferior horn is thus incised, and a sufficient amount of the lateral part of the temporal lobe must be removed to give a view of the cavity, but the surface of the insula should be preserved from injury.

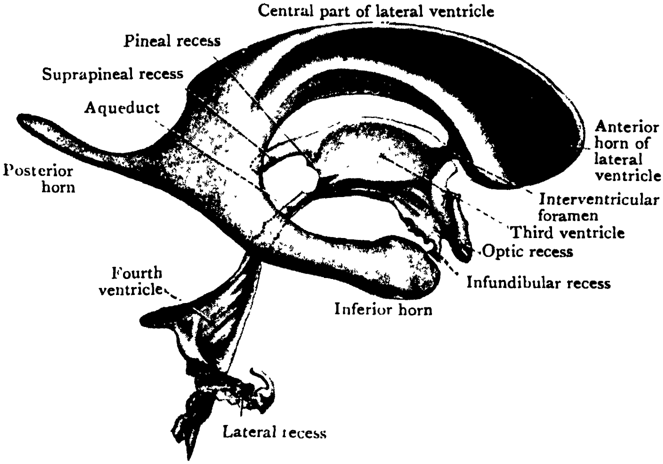

FIG. 191.—Cast of Ventricles of Brain. (From Retzius)

When the dissection is completed, the dissectors will note that in certain places the walls of the ventricle are in apposition with each other, but in others the walls are separated by spaces of varying capacity filled with cerebro-spinal fluid.

The lateral ventricle communicates with the third ventricle through the *interventricular foramen* (Figs. 185, 193). That aperture separates the anterior end of the thalamus from the anterior column of the fornix. It may be a round opening of some size or a mere slit. To find it, note the rough fringe of vascular pia mater which lies on the floor of the ventricle, and follow it forwards into the foramen.

The shape of the lateral ventricle is very irregular, but it is readily understood when a cast of the cavity, or a radiograph of a cast *in situ* is examined (Figs. 191, 195). The size and shape of the ventricle can be demonstrated also in the living head by radiography, after the injection of oxygen to replace an equivalent amount of cerebro-spinal fluid (Fig.

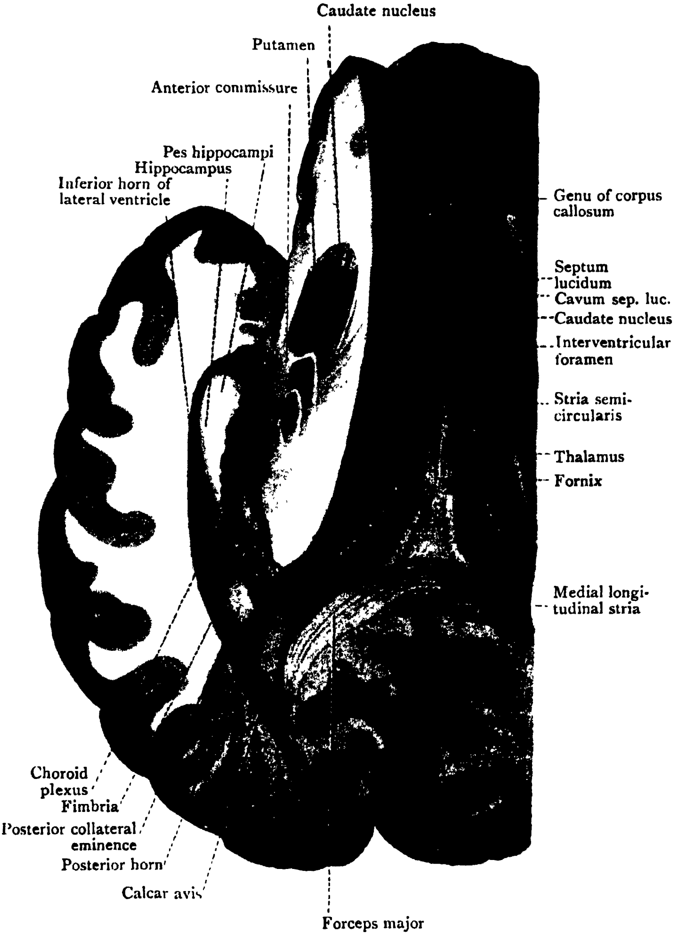

FIG. 192.—Dissection to show the Posterior and Inferior Horns of Lateral Ventricle of the left side.

194. *See also* Fig. 187). A cerebral tumour may be diagnosed and its exact position recognised by alterations in the size and shape of the ventricle ascertained in this way.

The divisions of the ventricle are a central part and three horns, viz., an anterior, a posterior, and an inferior. The *anterior horn* is the part in front of the interventricular foramen. The *central part* extends from the interventricular foramen to the splenium of the corpus callosum, where it is continuous with the posterior and inferior horns, which diverge from each other. The *posterior horn* curves backwards and medially into the occipital lobe. It is very variable in its length and capacity. The *inferior horn* descends, with a bold sweep, round the posterior end of the thalamus, and then extends downwards and forwards to the uncus (Figs. 192, 198).

The floor of the central part of the ventricle is fully exposed, and the following parts should be identified at once :—(1) A vascular fringe called the *choroid plexus of the lateral ventricle* extends backwards and laterally from the interventricular foramen, and disappears into the inferior horn. (2) The upper surface of the *body of the fornix*—white and shining—is seen medial to the choroid plexus. Posteriorly, each half of the fornix becomes a flattened band called the posterior column of the fornix, which accompanies the choroid plexus into the inferior horn; and, anteriorly, each half becomes a rounded pillar called the anterior column. (3) Lateral to the choroid plexus, a part of the *upper surface of the thalamus* is seen. (4) A slender, white strand, called the *stria semicircularis*, runs along the lateral margin of the thalamus from the column of the fornix, and bends downwards into the roof of the inferior horn ; a slender vein, called the *thalamo-striate vein*, runs forwards alongside the stria. (5) Lateral to the stria, there is the convex, upper surface of the body of the caudate nucleus.

Note also the *septum lucidum*, which connects the trunk and genu of the corpus callosum with the fornix, and forms the medial wall of the central part and anterior horn of the ventricle.

The **anterior horn of the lateral ventricle** extends forwards, laterally and downwards in the frontal lobe. When seen in coronal section it presents a triangular outline. The *floor* is narrow and is formed by the rostrum of the corpus callosum.

The *roof* is the under surface of the trunk of the corpus callosum. The *medial wall* is the anterior part of the septum lucidum ; it is vertical, and separates the anterior horns of the opposite sides from each other. The *lateral wall* is the head of the caudate nucleus ; it is a sloping wall, and also bulges into the horn (Fig. 193).

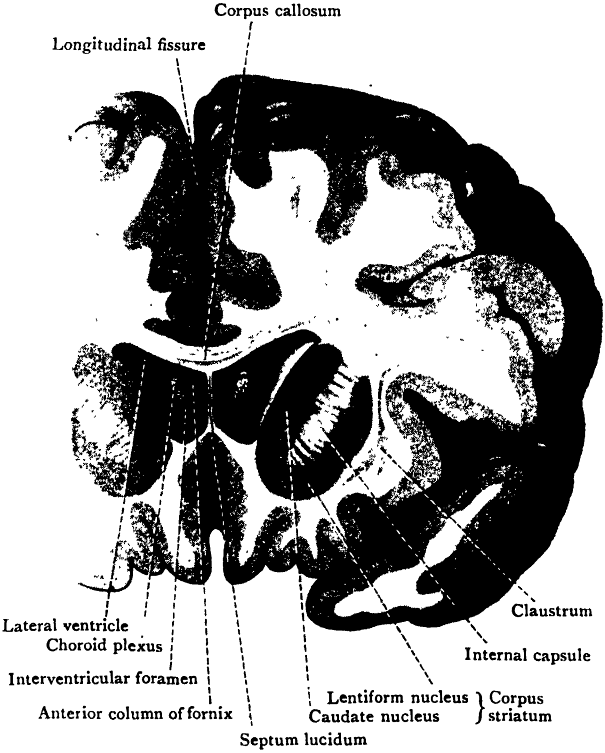

FIG. 193.—Coronal Section through Cerebrum behind the Genu of Corpus Callosum. Seen from in front.

The **central part of the ventricle** also is *roofed* by the trunk of the corpus callosum. On the *medial side*, it is bounded by the posterior part of the septum lucidum, and more posteriorly by the attachment of the fornix to the under surface of the corpus callosum behind the septum. On the *lateral side*, it is closed by the meeting of the roof and the floor of the cavity.

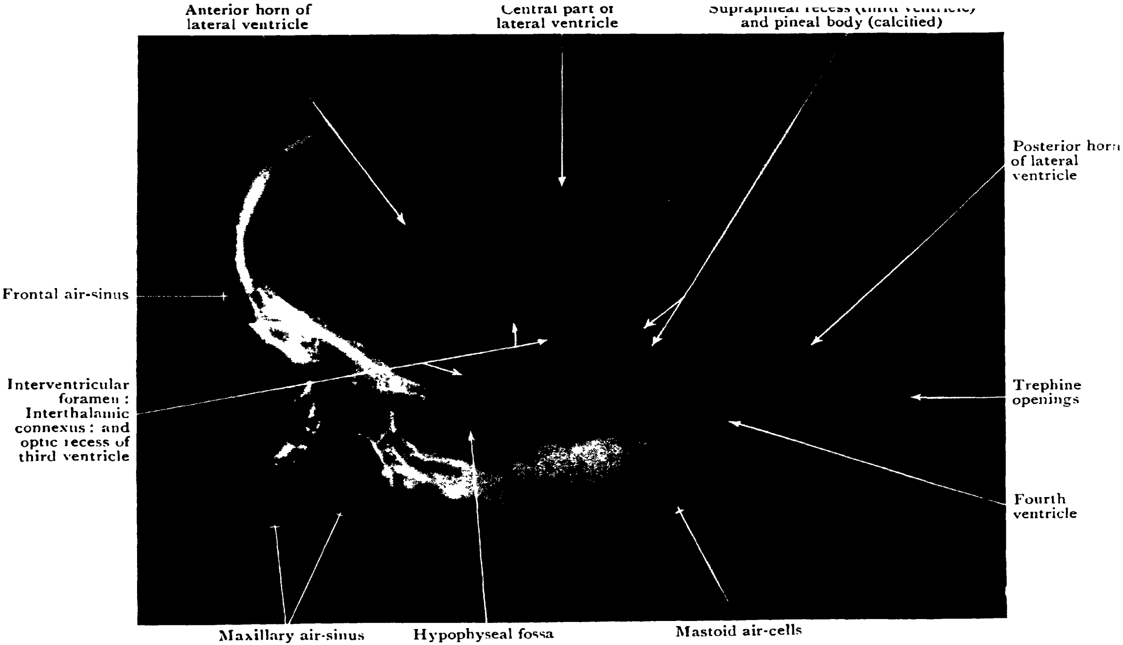
Anterior horn of lateral ventricle
Central part of lateral ventricle
Suprapineal recess (third ventricle) and pineal body (calcified)
Posterior horn of lateral ventricle
Frontal air-sinus
Interventricular foramen: Interthalamic connexus: and optic recess of third ventricle
Trephine openings
Fourth ventricle
Maxillary air-sinus
Hypophyseal fossa
Mastoid air-cells

FIG. 194.—Lateral Radiograph of Head of woman aged 47, after direct injection of oxygen into the Lateral Ventricles (Ventriculograph: Mr. Norman M. Dott). The oxygen-filled Ventricular System appears in the radiograph, like the air-filled sinuses, on account of its relative translucency to the X-rays. The central darker area is due to the overlap of the two Lateral Ventricles; in this patient they were pathologically distended, but the general form is well shown; compare with Fig. 187 for correct impression of the normal size. Note the details of the Third Ventricle. The Fourth Ventricle and the Aqueduct also are faintly seen.

PLATE XVI

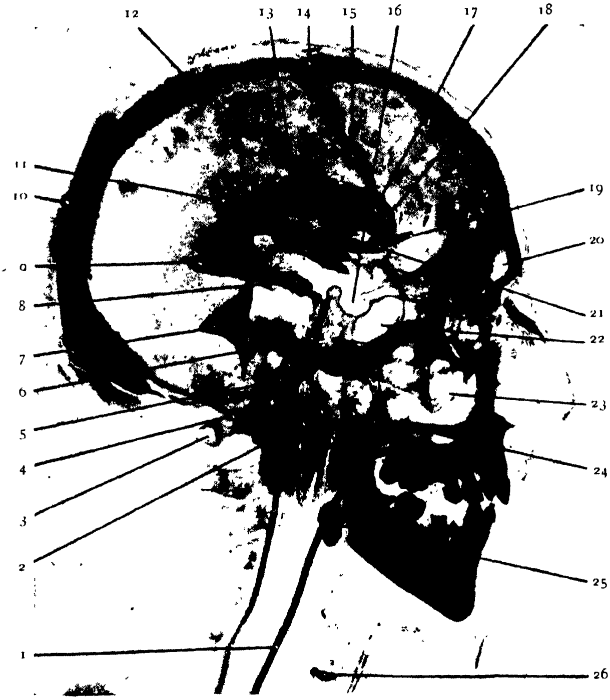

FIG. 195.—Radiograph of half of a Head (from positive print). The sulci and cavities shown were made visible by metal filaments or metal injections.

1. Line of cavity of pharynx.
2. Anterior arch of atlas.
3. Posterior arch of atlas.
4. Vertebral artery.
5. External auditory meatus.
6. Basilar artery.
7. Fourth ventricle.
8. Inferior horn of lateral ventricle.
9. Posterior horn of lateral ventricle.
10. Lambda.
11. Posterior end of posterior ramus of lateral sulcus.
12. Central sulcus.
13. Third ventricle.
14. Bregma.
15. Coronal suture.
16. Hypophyseal fossa.
17. Ascending anterior ramus of lateral sulcus.
18. Anterior horn of lateral ventricle.
19. Horizontal anterior ramus of lateral sulcus.
20. Frontal air-sinus.
21. End of stem of lateral sulcus.
22. Sphenoidal air-sinus.
23. Maxillary air-sinus.
24. Position of pharyngeal end of pharyngo-tympanic (auditory) tube.
25. Position of the tonsil.
26. Sinus of larynx.

In the *floor*, there are several important objects to which reference has been made previously. Latero-medially, and, at the same time, to some extent from before backwards, they are:—(1) the body of the caudate nucleus; (2) the stria semicircularis and the thalamo-striate vein; (3) a portion of the upper surface of the thalamus; (4) the choroid plexus; (5) the upper surface of one half of the fornix (Fig. 190).

The *body of the caudate nucleus* lies in the lateral part of the floor, and narrows rapidly as it passes backwards.

The *thalamo-striate vein* (vena terminalis) is seen through the ependyma. It ends in the internal cerebral vein at the interventricular foramen. The *stria semicircularis* (stria terminalis) is a slender white band which joins the anterior column of the fornix; its fibres ultimately reach the anterior perforated substance.

Only a narrow strip of the *upper surface of the thalamus* appears in the floor of the ventricle. The rest of the upper surface is hidden under the choroid plexus and the fornix.

The *choroid plexus of the lateral ventricle* is a convoluted plexus of small blood-vessels enclosed in the margin of a triangular fold of the pia mater called the tela chorioidea of the third ventricle. It appears as a rich vascular fringe from under cover of the edge of the fornix. It lies on the upper surface of the thalamus, from which it can be lifted up, for it is invested with a covering of ependyma below as well as above. It is continuous anteriorly, through the interventricular foramen, with the corresponding choroid plexus of the opposite side; posteriorly, it is carried into the inferior horn of the ventricle.

The **posterior horn** is the diverticulum of the ventricle which begins at the splenium and curves backwards into the occipital lobe, tapering to a point.

Its *roof* and *lateral wall* are formed by the tapetum of the corpus callosum (see p. 439). On the *infero-medial wall*, two elongated, curved elevations may be seen. The upper of the two is termed the *bulb of the posterior horn*, and is produced by the forceps major. The lower elevation is known as the *calcar avis*. It varies greatly in size, and is caused by an infolding of the ventricular wall which corresponds with the calcarine sulcus.

The **inferior horn** is the direct continuation of the main ventricular cavity into the temporal lobe—the posterior horn being merely a diverticulum from the main cavity.

At first directed backwards and laterally, the inferior horn suddenly sinks downwards, behind the thalamus, into the temporal lobe, in which it takes a curved course, forwards and medially, to end in the uncus. In the angle between the diverging inferior and posterior horns the cavity of the ventricle exhibits a triangular expansion of varying capacity. It is called the *collateral trigone*.

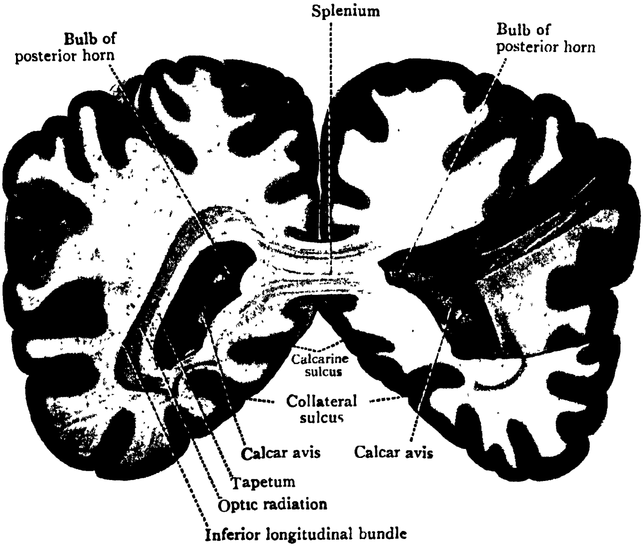

FIG. 196.—Coronal Section through Posterior Horns of Lateral Ventricles.

The *lateral wall* of the inferior horn is formed by the tapetum of the corpus callosum.

The anterior part of the *roof* is formed by a collection of grey matter, called the *amygdaloid nucleus*, which bulges slightly into the horn. The rest of the roof is formed of the *stria semicircularis* and the *tail of the caudate nucleus*. The tail of the nucleus begins at the posterior end of the floor of the central part of the ventricle, curves downwards into the inferior horn, and extends forwards in its roof to end by joining the amygdaloid nucleus. It is a very thin, but fairly wide, grey band; the stria semicircularis runs along its medial side, and also joins the amygdaloid nucleus.

The *floor* is formed, from the medial to the lateral side, by the fimbria, the hippocampus and the collateral eminence. A great part of the floor is, at present, concealed under the *choroid plexus of the inferior horn*, which must be turned aside.

The **hippocampus** is so named from a fancied resemblance to the peculiar little fish known as the hippocampus or sea-horse. It is a prominent, white elevation, curved in conformity with the course taken by the horn. Its posterior part is narrow and pointed and ends at the splenium. It enlarges as it is traced forwards, and it ends, below the amygdaloid nucleus, in a thickened, notched extremity called the *pes hippocampi*. The hippocampal elevation is due to masses of nerve-cells and the nerve-fibres associated with them—the fibres forming a white layer on its surface called the *alveus*.

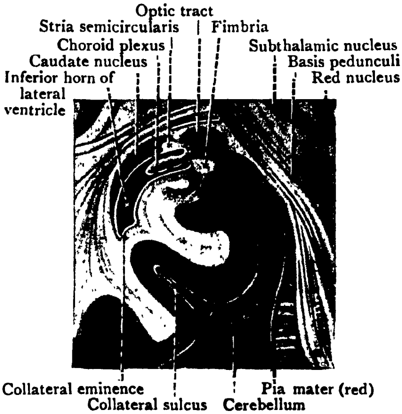

FIG. 197.—Coronal Section to show Relations of Inferior Horn of Lateral Ventricle. (Part of Fig. 213 enlarged)

The **fimbria** is a narrow but very distinct band of white matter which runs along the medial border of the hippocampus. Laterally, it is continuous with the alveus, but its medial margin is a sharp, free edge. Anteriorly, it ends in the tip of the recurved part of the uncus; posteriorly, it is continuous with the posterior column of the fornix. It is composed of fibres that arise in the hippocampus; these fibres first form the alveus and then enter the fimbria to reach the fornix.

The **collateral eminence** is a longitudinal elevation immediately lateral to the hippocampus. It is produced by the collateral sulcus, and is very variable—even absent if the inferior horn is narrow.

Choroid Fissure.—The choroid fissure of the cerebrum is the long, curved slit that separates (1) the fornix from the thalamus, and (2) the fimbria from the stria semicircularis in the roof of the inferior horn. Along that cleft, nervous matter failed to develop in the wall of the ventricle, and the wall consists therefore of ependyma only. The choroid plexus, enclosed in pia mater, is thrust through the fissure, pushing and stretching the ependymal wall before it; the plexus is therefore seen in inferior horn of the ventricle, but is excluded from the cavity by that ependymal covering. The choroid fissure is sometimes confused with the *transverse fissure*, which is the horizontal cleft below the splenium through which the layers of the tela chorioidea are continuous with the pia mater on the exterior of the brain.

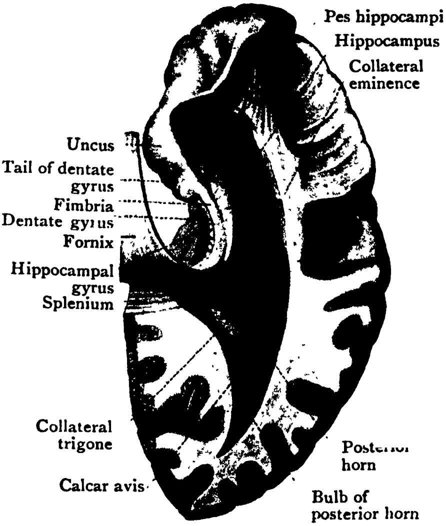

FIG. 198.—Dissection to show Posterior and Inferior Horns of Right Lateral Ventricle.

The dentate gyrus is intimately related to the hippocampus and the fimbria, but a further dissection is necessary for its exposure; and when that dissection is made, the floor of the inferior horn will be examined much more satisfactorily than it can be at the present stage.

Dissection.—Cut through the left forceps major near the splenium and through the fimbria where it passes into the posterior column of the fornix. Then, carry the knife forwards from the anterior extremity of the inferior horn, above the level of the uncus, through the temporal pole. The left temporal and

occipital lobes can then be separated from the remainder of the brain, along the line of the lower part of the choroid fissure.

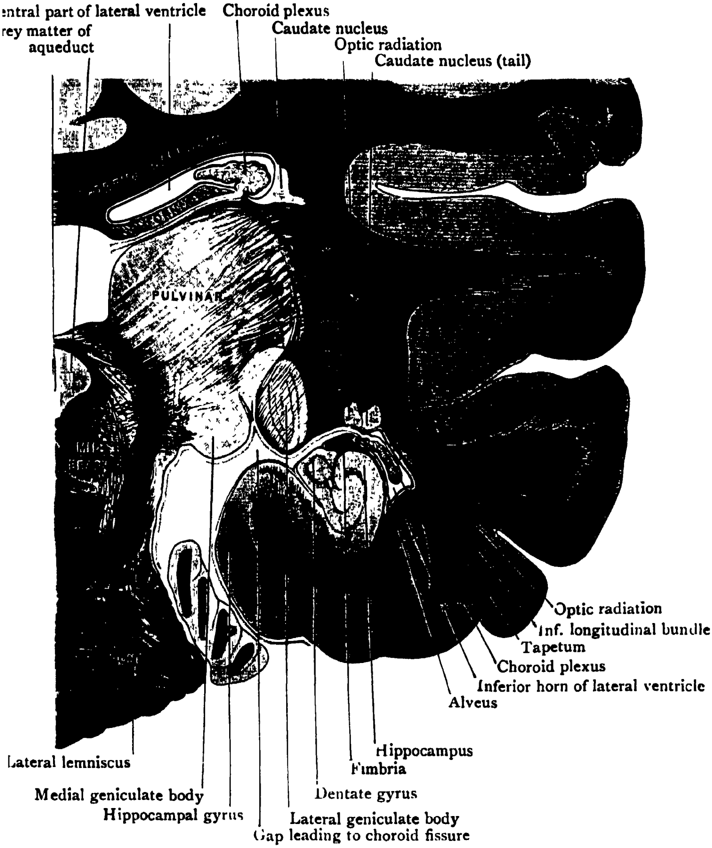

FIG. 199.—Coronal Section through Cerebrum, Mid-Brain, and Pons in the plane of the Geniculate Bodies. It shows the relation of the choroid plexuses to the ventricles.

Turn the larger part of the cerebrum upside down, and examine the roof of the inferior horn. Trace the caudate nucleus and the stria semicircularis from the floor of the central part of the ventricle into the roof of the inferior horn and forwards to the bulge made by the amygdaloid nucleus at the anterior end of the roof (if it has not been removed with the smaller part of the brain). Note how close the optic tract is to the stria semicircularis. Fit the smaller part on to the larger part to obtain a better idea of the lower part of the choroid fissure.

Now, inspect the floor of the inferior horn again. Note the presence or absence of the collateral eminence; examine the hippocampus again; trace the fimbria forwards to its termination in the tip of the medial part of the uncus, and then lift the edge of the fimbria in order to expose as much as possible of the dentate gyrus, whose medial margin lies under the edge of the fimbria and is easily recognised because it is divided by a number of notches into a row of blunt " teeth."

Dentate Gyrus.—This is a thin, narrow ribbon of grey matter largely enclosed within the hippocampus, but its medial part lies between the fimbria and the upper surface of the hippocampal gyrus, and sometimes its medial edge, which is free, juts out beyond the edge of the fimbria. Its upper surface is scored by numerous parallel grooves, and its medial edge is notched. Posteriorly, it is continued into the *splenial gyrus* (fasciola cinerea), which is a narrow band of grey matter that curves upwards from the dentate gyrus round the lateral part of the splenium to become continuous with the indusium. Anteriorly, the dentate gyrus runs into the cleft of the uncus. It emerges from the cleft in the form of a delicate band called the *tail of the dentate gyrus*, which curves medially and upwards over the recurved part of the uncus, and fades away.

Rhinencephalon.—The hippocampus (with the dentate gyrus) is associated with the uncus, which receives impressions from the olfactory bulb and tract. These parts of the hemisphere, together with their vestigial continuations on the surface of the corpus callosum and certain other parts, have been named the *rhinencephalon* (Fig. 184). The hippocampus is connected through the alveus and fimbria and fornix (*a*) directly with the hippocampus of the other side, and (*b*) indirectly with the thalamus and the brain-stem through the mamillary body and the mamillo-thalamic and mamillo-tegmental tracts (p. 452).

The dissectors will now turn to the larger part of the brain to study the septum lucidum and the fornix.

Dissection.**—Pare away the median part of the corpus callosum in order to expose the left side of the septum lucidum and left half of the fornix more fully.**

1. SEPTUM LUCIDUM—FORNIX—TELA CHORIOIDEA

Septum Lucidum.—This is a thin, vertical partition that intervenes between the anterior horns and central portions of the two lateral ventricles (Figs. 190, 200). It occupies the interval between the corpus callosum and the fornix, and is attached to them. It varies considerably in depth and also in length; it may extend almost to the splenium (Fig. 200) or it may fall considerably short of it. It is divided into a pair of thin laminæ partially separated by a median cleft called its *cavity* (Figs. 192, 201).

Dissection.—**If the dissectors have opened only the left ventricle, they should remove the left lamina of the septum lucidum, detaching it from both fornix and corpus callosum. If they have opened both ventricles, they should carefully remove the median strip of the corpus callosum, which is still in place, and should snip off the upper part of the septum lucidum. But the forceps minor and major should be preserved.**

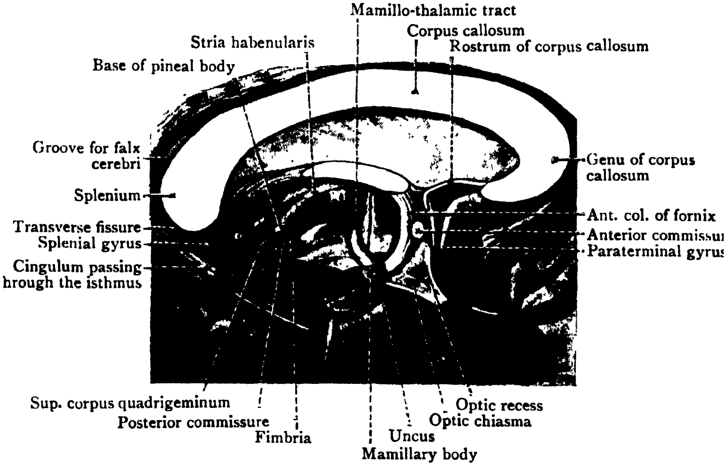

FIG. 200.—Dissection showing Relations of Fornix.

Fornix.—The fornix is an arched structure, composed of longitudinal and transverse fibres. Its main part or body ends in a pair of columns both anteriorly and posteriorly.

The *body of the fornix* is triangular in shape. Anteriorly, it is narrow, and its two halves separate to form the pair of anterior columns. Posteriorly, it broadens out, becomes flattened, and its two halves separate to become the two posterior columns (Fig. 198). The posterior part of the upper surface of the body is adherent to the lower surface of the trunk of the corpus callosum, near the splenium. The remaining part has a median attachment to the laminæ of the septum lucidum ; on each side of that, it lies in the floor of the central part of the lateral ventricle, and is clothed with ependyma. Each lateral margin is a sharp edge from under which the choroid plexus bulges into the lateral ventricle. The lower surface of the body of the fornix rests upon the tela chorioidea, which separates it from the two thalami and the ependymal roof of the third ventricle (Figs. 203, 212).

The *anterior columns* are a pair of rounded strands which emerge from the anterior end of the body of the fornix, and then, diverging slightly, pass downwards in front of the interventricular foramina and behind the anterior commissure. Each then sinks into the grey matter on the side wall of the third ventricle, and ends at the base of the brain in the mamillary body (Figs. 200, 204).

When the mamillary body is dissected, it has the appearance of being a twisted loop of the corresponding column of the fornix, in which the fibres turn upon themselves, and are then continued upwards and backwards into the anterior nucleus of the thalamus. The appearance, however, is deceptive. In the interior of the mamillary body there is a nucleus of grey matter. In that nucleus the fibres of the column end ; while the other fibres, which seem to be continuous with the fornix fibres, take origin within the nucleus. The strand, thus formed, is called the *mamillo-thalamic tract* (Fig. 200).

The connexions which have just been described cannot be made out at present, but at a later period (p. 461) the dissector will experience little difficulty in tracing a column of the fornix to the corresponding mamillary body, and in displaying the connexion of that body with the mamillo-thalamic tract.

A smaller bundle of fibres connects the mamillary body with the brainstem. From the mamillary body it passes backwards through the posterior perforated substance and then downwards in the tegmentum of the mid-brain ; it is named the *mamillo-tegmental tract.*

The *posterior columns* are a pair of flattened bands which begin at the posterior part of the body of the fornix. At first they are adherent to the under surface of the corpus callosum but soon they diverge from each other, and each sweeps downwards, round the posterior end of the thalamus and enters the inferior horn of the ventricle. There, each column comes into relation with the hippocampus, and is continuous with the fimbria and the alveus (Fig. 198).

All the fibres of the body do not pass into the posterior column. The upper medial fibres of each half of the body of the fornix form a small bundle which joins the splenium (Fig. 192), and then runs backwards with the bulb of the posterior horn, under cover of the ependyma, to reach the occipital lobe. The fornix belongs to the olfactory nervous apparatus; and this bundle may be a link between olfactory and visual centres.

Hippocampal Commissure.—The transverse fibres of the fornix cross the lower surface of the body and the anterior part of the interval between the posterior columns as they diverge from each other. In the latter place they may be adherent to the corpus callosum. On each side, they are continued into the posterior column, and so are prolonged into the fimbria and the alveus. They constitute a commissure from one hippocampus to the other.

***Dissection.*—Dissectors who have exposed only the left half of the fornix will split the fornix carefully along the median plane and will cut the beginning of the left anterior column, and then remove the half of the body of the fornix in order to expose the left half of the tela chorioidea.**

If they have opened both lateral ventricles, they will cut across the anterior end of the body and the origin of the right posterior column, and, lifting off the body of the fornix, will expose the whole of the tela.

Tela Chorioidea.—The tela chorioidea of the third ventricle consists of two layers of pia mater which form a fold of triangular outline (Fig. 201). It separates the body of the fornix from the roof of the third ventricle and the two thalami. Between the two layers there are blood-vessels and some subarachnoid tissue. The apex of the fold lies below the anterior end of the body of the fornix, between the interventricular foramina. The base is below the splenium of the corpus callosum; there, its upper layer becomes continuous with the pia mater on the corpus callosum, and the lower layer becomes continuous with the pia mater on the back of the mid-brain (Fig. 166).

Each margin of the tela contains the **choroid plexus** of the central part of the corresponding lateral ventricle. The plexus bulges into the ventricular cavity from under cover of the free edge of the fornix. Posteriorly, it is continuous with the part of the choroid plexus which lies in the inferior horn of the ventricle; anteriorly, it narrows greatly, and becomes continuous, across the median plane, with the corresponding plexus of the opposite side. From that median junction, a pair of much smaller choroid plexuses run backwards in the tela, bulging its lower layer downwards into the third ventricle; they are the *choroid plexuses of the third ventricle* (Fig. 203).

Internal and Great Cerebral Veins.—The most conspicuous blood-vessels in the tela are a pair of *internal cerebral veins* and a median vein called the *great cerebral vein.* Each internal cerebral vein is formed at the apex of the tela by the union of the thalamo-striate vein with a vein that issues from the choroid plexus. It runs backwards close to the median plane, and, at a varying point, it unites with its fellow to form the great cerebral vein. That vein runs backwards, escapes from between the layers of the tela at its base, curves upwards behind the splenium, and joins the inferior sagittal sinus to form the straight sinus (Fig. 34).

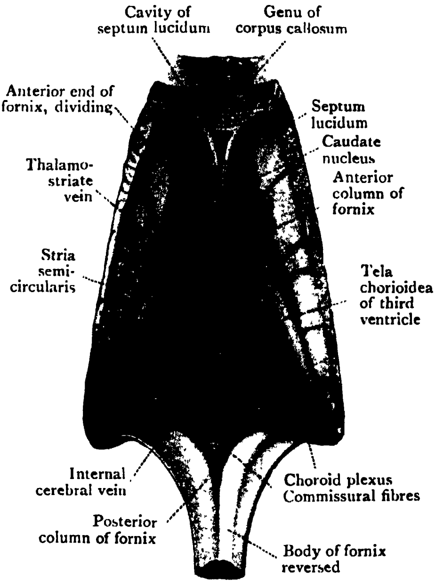

FIG. 201.—Dissection to show Tela Chorioidea of Third Ventricle and the parts in its vicinity. The fornix has been divided and thrown backwards.

The next step in the dissection is the exposure of the thalamus and the third ventricle. Begin by removing the tela.

***Dissection.*—If only one half of the body of the fornix was removed, divide the thalamo-striate vein where it joins the internal cerebral vein, split the tela along the median plane, and pull the left half of it backwards. If the whole fornix was removed, divide both thalamo-striate veins and pull the whole tela backwards.**

In either case, exercise care as the base of the tela is approached, for the *pineal body* is wrapped in a fold of its lower layer and is liable to be torn off.

The pineal body is a small conical body which lies between the posterior parts of the two thalami. Disengage it from the lower layer of the tela, dividing the splenium, if necessary, in order to obtain better access.

The removal of the half of the tela exposes the whole of the upper surface of the *thalamus*, and gives a partial view of the *cavity of the third ventricle*, for the ependymal roof of the ventricle is adherent to the tela and is torn away with it.

To expose the medial surface of the thalamus and obtain a better view of the boundaries of the third ventricle, separate the remains of the left hemisphere from the right. First, bisect the pineal body and a slender transverse band, called the *posterior commissure*, which lies below the anterior part of the pineal body. Next, pass the knife down into the third ventricle and divide the connexion between the two thalami. Then, turn to the lower surface. Enter the knife between the mamillary bodies and carry it forwards, bisecting the tuber cinereum, optic chiasma, lamina terminals, anterior commissure and the rostrum of the corpus callosum. Then, carry the knife accurately in the median plane through the posterior perforated substance and the upper half of the mid-brain. Now, turn to the upper surface again, and bisect the genu and the splenium. The two halves of the cerebrum are then separate.

THALAMI AND THIRD VENTRICLE

Thalamus.—The thalamus is a large mass of grey matter which lies obliquely across the path of the cerebral peduncle as it ascends into the hemisphere. It is a great sensory centre and relay-station. Sensory fibres which ascend through the brain-stem bring sensory impressions to it from the opposite half of the body. The coarser impressions are consciously perceived in the thalamus ; but the finer impressions are relayed in it, and transmitted to the cerebral cortex. These impressions are carried by fibres that arise in the thalamus, enter the internal capsule and pass thence in the corona radiata to the sensory centre in the cortex—that is, the post-central gyrus and the paracentral lobule.

In their anterior two-thirds, the two thalami lie close together, but are separated by the median cleft called the third ventricle ; the posterior thirds are farther apart and the corpora quadrigemina lie between them, but on a lower plane (Fig. 202).

Each thalamus has two ends—anterior and posterior—and four surfaces. The inferior and lateral surfaces are in apposition with, and, indeed, directly connected with adjacent parts. The superior and medial surfaces are free.

The *anterior end*, small and rounded, is postero-lateral to the anterior column of the fornix, and forms the posterior boundary of the interventricular foramen.

The *posterior end* is called the *pulvinar*. It is wide, and it is prominent, especially medially. It projects backwards, overhanging the mid-brain, and has therefore a free lower surface as well as an upper.

The *superior surface* of the thalamus is whitish, owing to a superficial coating of white matter. It is divided into lateral and medial parts by a faint, oblique groove which corresponds to the edge of the fornix. The medial part includes the whole posterior end. It is related to the tela chorioidea, and to the fornix above the tela. The lateral part includes the anterior end. It is free in the floor of the lateral ventricle, and is covered therefore with ependyma; and it is overlapped by the choroid plexus. The lateral margin of the upper surface is separated from the body of

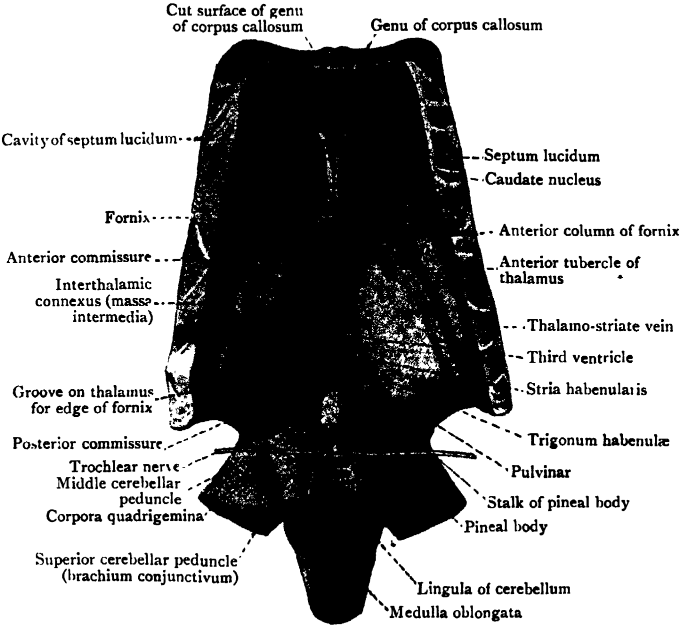

FIG. 202.—Thalami and Third Ventricle as seen from above.

the caudate nucleus by the groove that contains the thalamostriate vein and the stria semicircularis. The medial margin, in its anterior half or two-thirds is marked by a sharp ridge of the ependyma of the third ventricle raised up by a slender bundle of fibres called the *stria habenularis.*

The *medial surface* in its posterior part is narrow, overhangs the superior corpus quadrigeminum, and recedes from its fellow of the opposite side. In its anterior half or two-thirds, it forms a great part of the side wall of the third ventricle, is covered with ependyma, is close to its fellow and connected with it by a band of grey matter called the *interthalamic connexus.* Inferiorly, it is marked off from the region called the hypothalamus by a shallow groove. The groove is called the *hypothalamic sulcus*, and extends from the interventricular foramen to the upper end of the aqueduct of the mid-brain (Fig. 204).

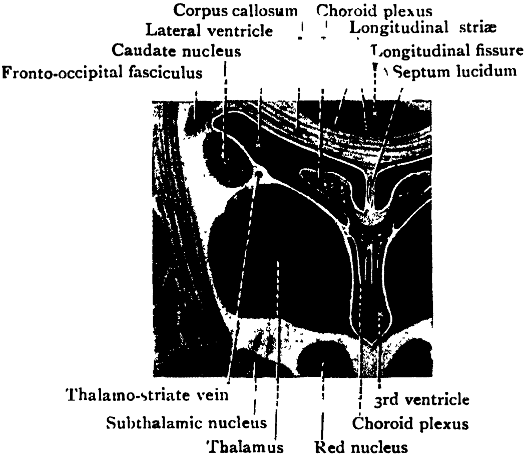

FIG. 203.—Coronal Section showing Relations of Thalamus and Lateral and Third Ventricles. (Part of Fig. 213 enlarged)

The *lateral surface* is quite hidden, for it is closely applied to the internal capsule (Figs. 208, 213).

The anterior and larger part of the *inferior surface* also is concealed, and rests upon the parts included under the name hypothalamus or subthalamic region, which is largely the upward continuation of the tegmentum of the mid-brain.

But the posterior part of the inferior surface is free. Turn the specimen upside down, and identify this part. It is the lower surface of the pulvinar. Inspect it carefully to find the **lateral geniculate body**, which is the principal *lower centre for sight*. It is an ill-defined swelling on the lateral part of the lower surface of the pulvinar, and the lateral margin of the optic tract can be traced into it.

Identify the **medial geniculate body** at the same time. It is the principal *lower centre for hearing*; and it is more conspicuous than the lateral body. It is a small, well-defined oval eminence situated about half an inch medial to the lateral body, and lies at the upper end of the lateral groove of the mid-brain under shelter of the pulvinar; the medial margin of the optic tract can be traced into it.

Developmentally, the geniculate bodies are parts of the thalamus, and are specialised for the reception of visual and auditory sensations. See 493.

Anterior and Posterior Commissures and Pineal Body.—The *anterior commissure* is a round bundle that crosses the median plane immediately in front of the anterior columns of the fornix. It will be traced afterwards to the temporal lobe, in which most of its fibres end.

The *posterior commissure* is a slender but conspicuous band that crosses the median plane immediately behind the upper end of the aqueduct and below the pineal body.

The *pineal body* is a small gland-like structure, shaped like a fir-cone but no larger than a cherry-stone, placed between the posterior parts of the two thalami. It lies in the groove between the two superior corpora quadrigemina of the mid-brain enclosed in pia mater derived from the lower layer of the tela chorioidea. The pineal body is of doubtful function; in middle age it often becomes calcified (Fig. 194).

The base of the pineal body is directed forwards and is attached by means of a hollow stalk. The stalk is divided into an upper and a lower part by a continuation into it of a pointed recess of the third ventricle. The lower part is folded downwards round the front of the posterior commissure to become continuous with the grey matter around the aqueduct. The upper part divides into right and left halves; each half is called the *habenula*, and becomes continuous with the ependymal ridge that overlies the stria habenularis. (Derived from *habenæ*=reins.)

Trigonum Habenulæ.—The trigonum habenulæ is a small triangular depression bounded by the stalk of the pineal body, the pulvinar and the superior corpus quadrigeminum. Its floor is slightly elevated by a collection of grey matter called the **habenular nucleus.** A small bundle of fibres called the *fasciculus retroflexus* arises in the nucleus and descends through the tegmentum to end in the *interpeduncular nucleus*, which is a small, median collection of cells placed in the posterior perforated substance.

The *habenular stria* (stria medullaris) is the slender bundle that lies in the ependymal ridge on the medial margin of the thalamus. Traced forwards, its fibres join the anterior column of the fornix, and most of them descend to the anterior perforated substance. Traced backwards, some of them end in the habenular nucleus of their own side; others cross in the upper part of the pineal stalk and end in the opposite habenular nucleus. These crossing fibres form what is called the *habenular commissure*.

Third Ventricle.—This is the name given to the cleft between the two thalami. It extends from the pineal body to the anterior commissure and lamina terminalis, and is much deeper anteriorly than posteriorly; and a little in front of its middle, the cavity is crossed by the interthalamic connexus.

Its *posterior wall* is formed by the base of the pineal body and the posterior commissure. Below the commissure, there is the opening of the aqueduct, by which the third ventricle communicates with the fourth.

The *floor* is formed, posteriorly, by the two tegmenta of the mid-brain as they separate from each other to enter the two halves of the cerebrum, and, farther forward, by the parts already studied in the interpeduncular fossa—viz., the posterior perforated substance, the mamillary bodies and the tuber cinereum, and by the optic chiasma, which lies at the junction of the floor and the anterior wall.

Anteriorly, it is bounded by the lamina terminalis, the anterior commissure, and the anterior columns of the fornix.

The *roof* is formed of the ependyma which stretches from the medial margin of one thalamus to that of the other. It is applied to the lower surface of the tela chorioidea, and is bulged into the ventricle by the pair of choroid plexuses of the third ventricle. In the removal of the tela, the ependymal roof was torn away.

Each *side wall* is formed by the medial surface of the thalamus and hypothalamus. At the anterior and upper part of the side wall, the *interventricular foramen* is seen leading into the lateral ventricle; through it, the ependyma and cavities of the ventricles are continuous.

The interventricular foramen is bounded anteriorly by the anterior column of the fornix. At the lower margin of the foramen, the column turns laterally, sinks into the hypothalamus, and descends in it to reach the mamillary body. The thalamus forms the upper part of the side wall of the ventricle. The lower and anterior parts are formed by the hypothalamus, which includes the continuation of the tegmentum upwards to join the thalamus, the grey matter around the anterior column of the fornix, and the wall of the cavity of the tuber cinereum. An indication of the double nature of the side wall is given by the shallow groove, called the *hypothalamic sulcus*, which runs along it from the interventricular foramen to the aqueduct.

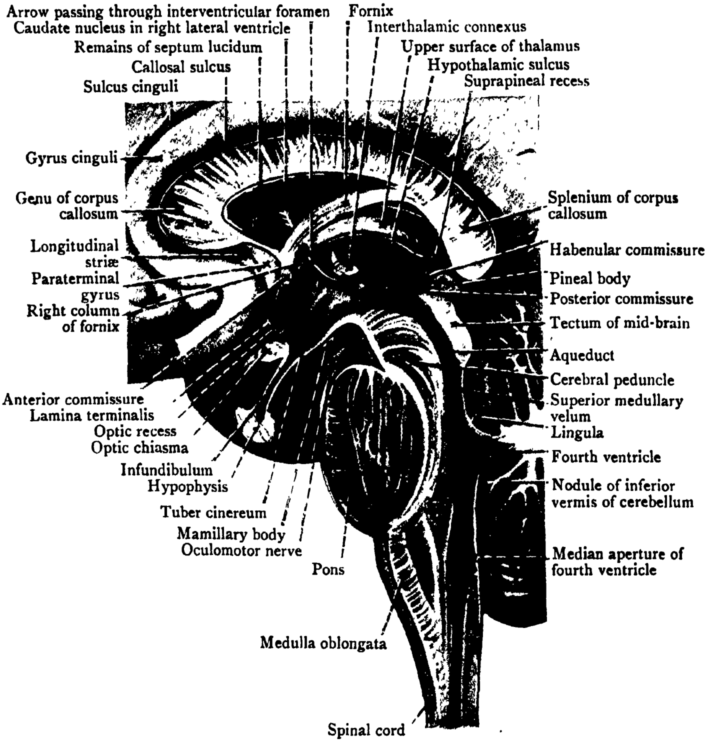

FIG. 204.—Sagittal Section of Corpus Callosum, and lower part of Brain (part of FIG. 161, p. 381). The septum lucidum has been removed and the cavity of the right lateral ventricle is thus exposed.

Recesses of Third Ventricle.—The outline of the third ventricle is very irregular (Figs. 191, 204). It presents several diverticula or recesses. In the anterior part of the floor, a deep funnel-shaped recess, called the *infundibular recess*, leads down, through the tuber cinereum, into the infundibulum of the hypophysis. The *optic recess* separates the lower part of the lamina terminalis from the front of the optic chiasma. The *triangular recess* is the little space above the anterior commissure, between the anterior columns of the fornix. The *pineal recess* burrows into the base of the pineal body. The *suprapineal recess* is larger (Figs. 191, 195). It is an ependymal pouch that extends backwards above the pineal body; it is enveloped in the lower layer of the tela chorioidea, and is therefore torn away.

Mamillo-Thalamic Tract.—The dissectors should turn back to p. 452 and read the paragraphs on the mamillary body and mamillo-thalamic tract, and then make the following dissection on the right hemisphere.

Dissection.—**Make two parallel cuts through the ependyma from the margins of the anterior column of the fornix to the margins of the mamillary body. Remove the ependyma and the grey matter between these cuts, beginning at the column of the fornix. Remove the superficial coating of the mamillary body, and note the figure-of-eight bend which the fibres of the column seem to make in it. Find the beginning of the *mamillo-thalamic tract* at the medial and posterior part of the mamillary body. Follow it upwards into the thalamus—cutting the ependyma with the knife, and removing the grey matter with the forceps. But do not follow it farther than the hypothalamic sulcus, else the thalamus, which is to be studied later in horizontal section, will be damaged.**

The further study of the cerebral hemispheres should be postponed until the mid-brain has been examined.

Dissection.—**Remove the membranes from the upper surface of the cerebellum. Pull back its anterior parts to expose :—(1) the *inferior corpora quadrigemina* ; (2) the *superior peduncles of the cerebellum* (p. 379) ; (3) a thin, tongue-like process of the cerebellum, called the *lingula*, that lies between the two peduncles ; (4) the *superior medullary velum*—largely covered by the lingula ; (5) the *trochlear nerves* (p. 379).**

Having identified those structures, remove the remains of the membranes from the lower half of the mid-brain—taking great care not to pluck away the trochlear nerves.

The upper part of the mid-brain was bisected when the third ventricle was exposed. Clean the remains of the membranes from the surfaces of its two halves.

Assemble the parts into which the brain has been divided. Place them together so that the parts of the mid-brain fit each other, and fix them with pins till the surface of the mid-brain as a whole has been studied.

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MID-BRAIN

The mid-brain or mesencephalon is the short, thick stalk which occupies the notch of the tentorium cerebelli, and connects the cerebrum with the parts in the posterior cranial fossa. It is about an inch long and rather more than an inch in width. It is tunnelled from end to end by a narrow channel, called the *aqueduct*, which connects the third ventricle with the fourth. The aqueduct is much nearer the back of the mid-brain than the front, and is surrounded by a thick tube of grey matter. The portion of the mid-brain behind the plane of that grey tube is called the *tectum*. The part in front of that plane is very much larger, and its two halves, which are partly separated from each other, are called the *cerebral peduncles*. In the undissected brain, the tectum is completely hidden from view by the splenium of the corpus callosum, which projects backwards over it, and also by the superimposed cerebral hemispheres. The peduncles, however, can be seen, to some extent, at the base of the brain, where they bound the posterior part of the interpeduncular fossa.

Tectum (Lamina Quadrigemina).—The tectum is directly continuous, in front, with the cerebral peduncles. Its posterior surface is raised into four eminences called the *corpora quadrigemina*—a *superior* pair and an *inferior* pair.

Corpora Quadrigemina.—Each corpus quadrigeminum is composed, for the most part, of grey matter, but it has a superficial coating of white matter.

A pair of large, round bundles of fibres called the superior cerebellar peduncles have already been seen emerging from the cerebellar hemispheres, approaching each other and sinking into the mid-brain under the inferior corpora (p. 379); it has been noted also that the peduncles are connected with each other by a thin white lamina called the superior medullary velum. Note now that the four corpora quadrigemina are separated from one another by a cruciform groove and that, from the lower end of the median part of the groove, a short and narrow but well-defined ridge runs down to end on the superior medullary velum. That white band or ridge is called the *frenulum veli*; and the trochlear nerves emerge through the velum at the sides of it. The upper part of the median groove is occupied by the pineal body.

The inferior pair of corpora quadrigemina are **reflex centres for hearing**. The superior pair are **reflex centres for sight**, and they are connected with the spinal cord by two important pairs of strands of fibres called the *tecto-spinal* and *spino-tectal tracts*.

The transverse groove that separates the two pairs of corpora extends on to the sides of the mid-brain, where it separates ridges called the brachia quadrigemina.

Brachia Quadrigemina.—The *inferior brachium quadrigeminum* is a fairly well defined ridge composed of a bundle of fibres that extends from the inferior corpus quadrigeminum to the medial geniculate body, which is the lower centre for hearing (p. 458). The brachium was cut across when the mid-brain was first divided. The *superior brachium quadrigeminum* is longer but more difficult to trace. It connects the superior corpus quadrigeminum with the lateral geniculate body, which is the lower centre for sight. To reach the lateral body, it passes above the medial geniculate body, and is hidden in the groove between that body and the pulvinar.

By means of the brachia and the geniculate bodies, the corpora quadrigemina are brought into association with the optic tract, which contains not only visual fibres but also some commissural fibres that connect the right and left auditory centres.

Optic Tracts.—These tracts have been seen already in the base of the brain. Each begins at the chiasma, runs backwards and laterally between the tuber cinereum and the anterior perforated substance, and disappears under cover of the uncus. There, it continues its direction backwards and laterally, running in close contact with the upper end of the basis pedunculi—*i.e.* at the junction of the basis with the internal capsule. At the postero-lateral border of the basis, it is close to the medial margin of the roof of the inferior horn of the lateral ventricle, and is a little in front of the geniculate bodies. It ends at that point by dividing into two ill-defined roots—a lateral and a medial.

The *lateral root* contains all the visual fibres, and it enters the lateral geniculate body. Most of its fibres end in that body ; but some run on in the superior brachium to the mid-brain to end in the superior corpus quadrigeminum and in the nucleus of the oculomotor nerve. The visual fibres arise in the retina and run in the optic nerve to the chiasma. Those from the lateral half of the retina run on in the tract of the same side, while those from the medial half cross in the chiasma and enter the tract of the opposite side. The lateral root of the right tract therefore contains the fibres from the right half of each retina, and the fibres from the left halves pass to the lateral root of the left tract.

The *medial root* enters the medial geniculate body. Its fibres are commissural fibres that connect the lower auditory centres of the two halves of the brain. They arise in a medial geniculate body, run forwards in the tract, cross in the chiasma, and run backwards in the opposite tract to the other medial geniculate body; some of them end there, while others run on in the inferior brachium to the inferior corpus quadrigeminum.

Cerebral Peduncles.—The peduncles constitute the chief bulk of the mid-brain. Each of them is made up of three parts—the tegmentum posteriorly, the basis pedunculi anteriorly, and the substantia nigra between those two.

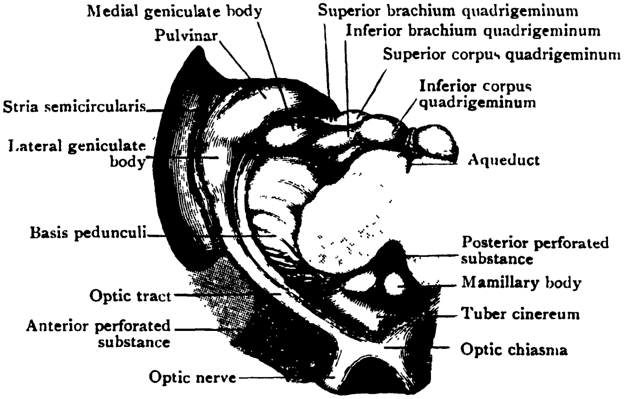

Medial geniculate body
Pulvinar
Superior brachium quadrigeminum
Inferior brachium quadrigeminum
Superior corpus quadrigeminum
Inferior corpus quadrigeminum
Stria semicircularis
Lateral geniculate body
Aqueduct
Basis pedunculi
Posterior perforated substance
Mamillary body
Optic tract
Tuber cinereum
Anterior perforated substance
Optic chiasma
Optic nerve

FIG. 205.—Origin and Relations of Optic Tract. (Thane, from *Quain's Anatomy*)

Basis Pedunculi.—The basis pedunculi is the part most easily seen, for it appears at the surface in the base of the brain. It is a thick, wide, white bundle, streaked spirally (which gives it a resemblance to a piece of rope); and it is composed of fibres that arise in the cerebral cortex. Inferiorly, it approaches its fellow and sinks into the anterior or basilar part of the pons. Superiorly, it widens, diverges from its fellow and enters the cerebral hemisphere, where it at once becomes continuous with the internal capsule. Its superficial surface is overlapped by the uncus, and is crossed by the optic tract, the posterior cerebral artery, the basal vein and the trochlear nerve. Its deep surface is in contact with the substantia nigra, which separates it from the tegmentum. Its lateral margin is separated from the tegmentum by a shallow groove —the *lateral sulcus* of the mid-brain—at whose upper end the medial geniculate body is lodged. The medial margin bounds the interpeduncular fossa, and is separated from the tegmentum by a narrow furrow—the *medial sulcus*—which gives exit to the rootlets of the oculomotor nerve.

The fibres that compose the basis are (1) cortico-pontine fibres, (2) motor fibres.

The *cortico-pontine fibres* arise in the various parts of the cerebral cortex. They pass in the corona radiata to the internal capsule, and thence, in the basis pedunculi, to the basilar part of the pons, where they end in little collections of grey matter called *nuclei pontis* ; new relays of fibres arise in those nuclei and pass into the opposite half of the cerebellum. By those means the cerebral cortex exercises control over the activities of the cerebellum. The cortico-pontine fibres from the anterior part of the cerebral cortex occupy the medial fifth of the basis, and those from the lower and posterior parts occupy the lateral fifth.

The *motor fibres* occupy the intermediate three-fifths of the basis. They arise in the pre-central gyrus and the para-central lobule. They descend through the corona radiata and internal capsule to the basis, and thence through the basilar part of the pons to the medulla oblongata, where they form the pyramid ; and from the medulla oblongata, they descend into the spinal cord. On their way down the brain-stem, many of them pass across to end in the motor nuclei of cranial nerves of the opposite side. In the lower part of the medulla oblongata, most of them cross, in the decussation of the pyramids, to descend in the opposite half of the spinal cord ; and those which enter their own half of the spinal cord ultimately cross to the opposite side. In the basis pedunculi, they are arranged in the following order :—The fibres for the head are most medial, then the upper limb and the trunk, and those for the lower limb are most lateral.

Substantia Nigra.—This is a plate of dark-coloured matter set between the basis and the tegmentum. It begins at the upper border of the pons and extends upwards into the hypothalamic region. It appears to be a centre concerned with muscular tone and skilled movements ; it is connected with a part of the corpus striatum called the globus pallidus, but its other connexions are uncertain.

When a section is made across the mid-brain, the medial margin of the substantia nigra is seen to come to the surface at the medial sulcus of the mid-brain, and its lateral margin is separated only by a thin layer of white matter from the surface at the lateral sulcus. The surface turned towards the tegmentum is concave and uniform; the opposite surface is very irregular owing to numerous processes which project from it into the basis pedunculi.

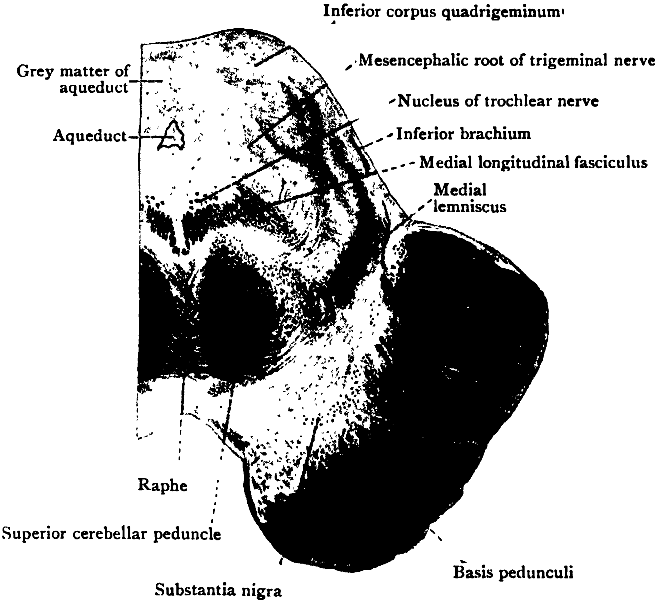

Inferior corpus quadrigeminum
Mesencephalic root of trigeminal nerve
Grey matter of aqueduct
Nucleus of trochlear nerve
Aqueduct
Inferior brachium
Medial longitudinal fasciculus
Medial lemniscus
Raphe
Superior cerebellar peduncle
Basis pedunculi
Substantia nigra

FIG. 206.—Transverse Section through Mid-Brain at the level of Inferior Corpus Quadrigeminum: the right side only is reproduced.

The drawing is taken from a Weigert-Pal specimen, and therefore the grey matter is pale and the strands of white matter are dark. The dark colour of substantia nigra is not evident owing to the thinness of the section.

Tegmentum.—The tegmentum is a thick column of grey and white matter mixed. Medially, it is fused with its fellow, except a small part in front which appears in the interpeduncular fossa between the medial sulcus and the bottom of the interpeduncular fossa (Fig. 206). Inferiorly, it is continuous with the posterior or dorsal part of the pons. Superiorly, it separates from its fellow and is prolonged upwards for a short distance, as part of the hypothalamus, to fuse with the lower surface of the thalamus. Anteriorly, it is separated from the basis by the substantia nigra. Posteriorly, it is fused with the tectum. Its lateral surface is free, but is crossed by the brachia quadrigemina.

In the centre of the upper half of the tegmentum, there is a round rod of reddish grey matter that extends upwards into the hypothalamus. It is called the **red nucleus,** and is a nerve centre concerned principally with the regulation of the tone of the muscles by which bodily equilibrium is maintained. It has numerous connexions, the chief of which are :—(1) the *superior cerebellar peduncle* of the opposite side, whose fibres cross to end in it, and bring impulses from the cerebellum, which is the central organ for equilibration; and (2) a bundle of fibres, called the *rubro-spinal tract,* which descends from it to the motor cells of the opposite half of the spinal cord.

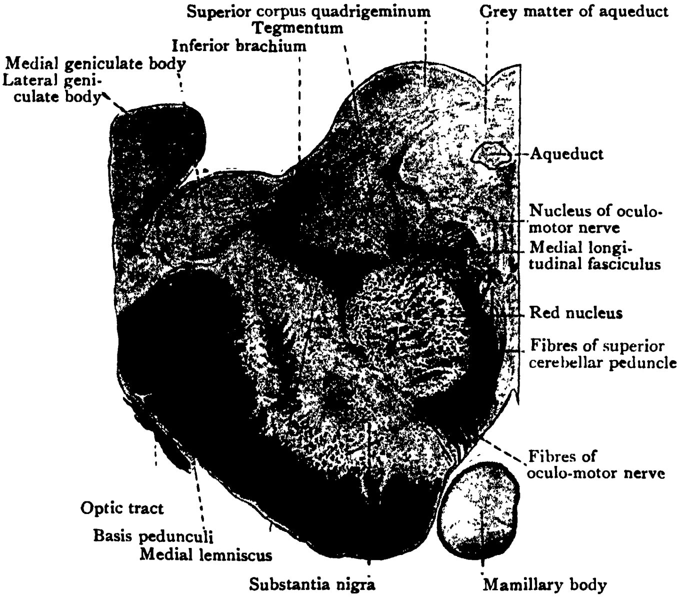


FIG. 207.—Section through upper part of Mid-Brain at the level of Superior Corpus Quadrigeminum. (From a Weigert-Pal specimen)

The *aqueduct* is situated far back between the two tegmenta. A thick tube of grey matter surrounds it, and contains the nuclei of the oculomotor and trochlear nerves and the uppermost nucleus of the trigeminal nerve.

Make a fresh section across one of the halves of the upper part of the mid-brain. If the specimen is in fairly good condition, the *substantia nigra* will be seen distinctly; the *grey matter around the aqueduct* will be dimly marked off from the whiter matter around it; the *red nucleus* will appear as a relatively large, dull red, circular area in the centre of the tegmentum. A few curved streaks may be seen; these are fibres of the *oculomotor nerve* arching forwards from the grey matter around the aqueduct, through the red nucleus and through the medial margin of the substantia nigra, to emerge through the medial sulcus of the mid-brain. If the distinction between the grey and the white matter is exceptionally clear, the section of a small white bundle may be seen pressed against the antero-lateral surface of the grey matter of the aqueduct. It is the *medial longitudinal bundle*; it extends throughout the whole length of the brain-stem, and consists of fibres that connect together the nuclei of the cranial nerves in order that they may work in harmony—for example, to turn the eyes towards the place from which a sound is heard.

Besides the medial longitudinal bundle, the superior cerebellar peduncle and the rubro-spinal tract, there are other bundles of fibres in the tegmentum, though they cannot be detected as separate bundles by the naked eye. The chief of these are the spino-thalamic tracts, the spino-tectal and tecto-spinal tracts, and the lateral and medial lemnisci.

The *spino-tectal fibres* bring sensory impressions from the opposite half of the spinal cord to the superior corpus quadrigeminum; the *tecto-spinal fibres* convey impulses from the corpus quadrigeminum to the motor nuclei of the opposite half of the brain stem and spinal cord whereby eyes and body are turned towards the cause of the sensory impression. The *spino-thalamic fibres* come from the opposite half of the spinal cord; and the *medial lemniscus* is a large bundle that arises in the opposite half of the medulla oblongata; the spino-thalamic tracts and the medial lemniscus are the great sensory paths by which ordinary sensations are conveyed from one half of the body to the thalamus of the opposite side.

The *lateral lemniscus* is part of the auditory nervous apparatus. Its fibres arise in the pons and end in the centres for hearing—medial geniculate and inferior quadrigeminal bodies—and in the substantia nigra. It lies at the surface of the tegmentum and can be exposed by a little dissection. Pull back or tear away the part of the cerebellum that overlaps its superior peduncle. With fine pointed forceps, scrape away the neuroglia from the surface of the peduncle. At once it will be evident that, while the fibres of the peduncle run upwards, there is a thin, fairly wide band of oblique fibres that overlies the upper part of the peduncle and disappears under the inferior brachium ; that band is the lateral lemniscus.

The dissectors will now return to the cerebrum, and complete its dissection—beginning with the examination of the basal nuclei, and then passing to the study of the composition of the thalamus and the external and internal capsules.

BASAL NUCLEI

The basal nuclei are (1) the caudate and lentiform nuclei, which, together, form the corpus striatum, (2) the claustrum, and (3) the amygdaloid nucleus.

To display the relative positions of the nuclei and their naked-eye structure, the dissectors must use both halves of the cerebrum. If, so far, they have kept the right half intact for the revision of the surfaces, they must keep that end in view still. They may make more than one section through the remains of the left hemisphere ; but one cut through the right hemisphere must suffice, and the two parts can be pinned together again when the surfaces are revised. The structure may be studied also in specially stained macroscopic sections.

Dissection.—Make a horizontal cut through the *right* half of the cerebrum at the level of the upper part of the interventricular foramen. Unless the knife is exceptionally sharp, the membranes and vessels will have to be removed before the cut is made. They may be removed from the whole hemisphere ; but if it is desired to keep them for purposes of revision, it will be enough to remove them from the horizontal strip that corresponds to the cut to be made.

Through the remains of the left half, make a number of vertical transverse sections—the *first*, immediately in front of the posterior end of the olfactory tract ; the *second*, through the anterior perforated substance ; the *third*, immediately in front of the mamillary bodies ; and the *fourth*, through the cerebrum and then through the front part of that portion of the cerebral peduncle which is still attached to it.

After the sections have been made, examine the horizontal section first (Figs. 208, 209), and note the following points, using the upper surface of the lower segment :—

(1) The peripheral grey matter and the central white matter.

(2) Close to the median plane, from before backwards—(*a*) the divided anterior part of the corpus callosum and the

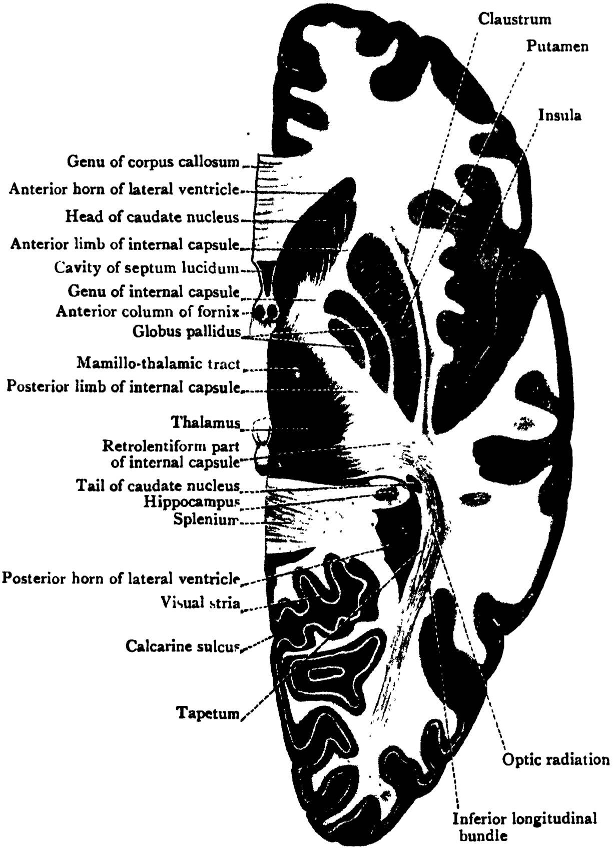


FIG. 208.—Horizontal Section through Right Cerebral Hemisphere at the level of the widest part of Lentiform Nucleus.

fibres of the forceps minor curving forwards from it; (*b*) the right layer of the septum lucidum; (*c*) the divided anterior column of the fornix; (*d*) the medial part of the thalamus, separated from the column of the fornix by the interventricular foramen; (*e*) medial to the posterior part of the thalamus, the upper surface of the superior corpus quadrigeminum and a half of the pineal body.

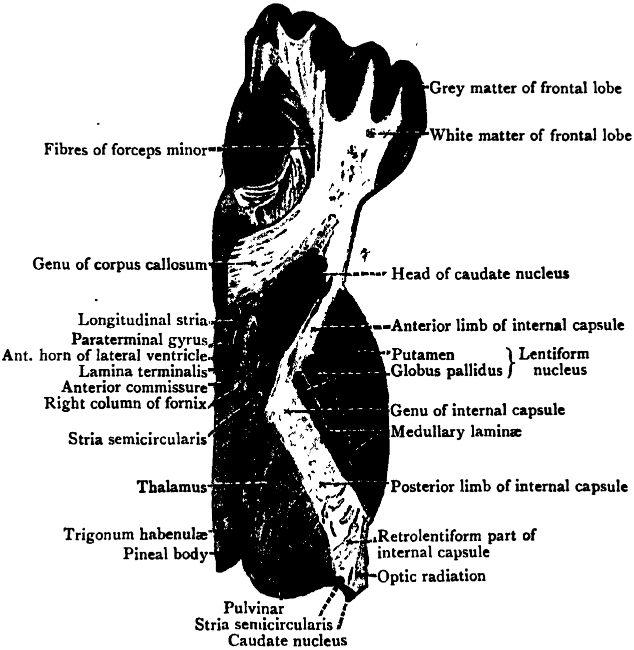


FIG. 209.—Horizontal Section of Corpus Striatum and adjacent parts on the right side, after the dissection represented in Fig. 219 had been made.

(3) Lateral to the anterior part of the corpus callosum,—the anterior horn of the lateral ventricle.

(4) In the lateral wall of the anterior horn—the divided head of the caudate nucleus.

(5) Bounded medially by the head of the caudate nucleus and the thalamus—a broad, white band called the ***internal capsule.***

(6) Lateral to the internal capsule—a triangular mass of grey matter called the *lentiform nucleus*. It is divided into three parts by two thin, white laminæ called medullary laminæ. The most lateral of the three parts is called the *putamen* ; it is larger than the medial two portions, which are named the *globus pallidus* because they are paler than the putamen.

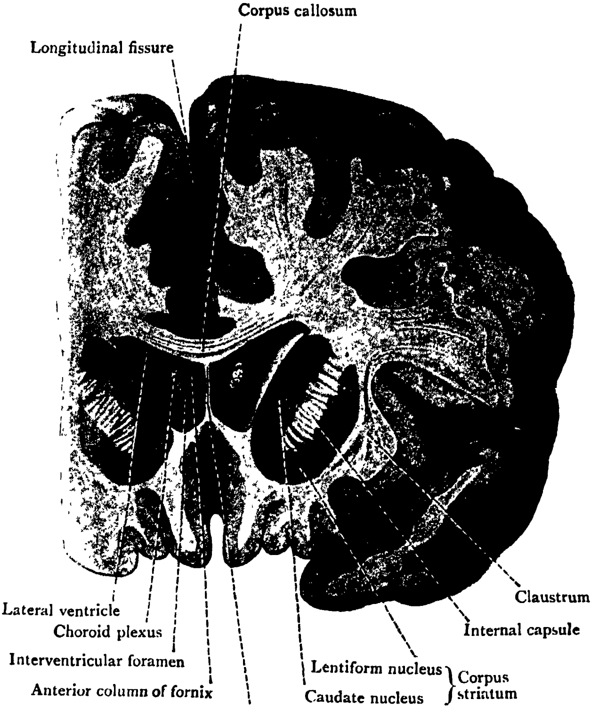


FIG. 210.—Coronal Section through Cerebral Hemisphere cutting through the anterior part of Lentiform Nucleus. Seen from in front.

(7) Lateral to the lentiform nucleus, a thin lamina of white matter called the *external capsule* separates the lentiform nucleus from—

(8) A thin lamina of grey matter called the *claustrum*, which has a smooth medial surface and a scalloped lateral surface.

(9) The white and the grey matter of the *insula*, which is lateral to the claustrum.

(10) Beyond the insula—the *opercula*. And there may be branches of the *middle cerebral vessels* still remaining in the lateral sulcus, between the insula and the opercula.

(11) At the postero-lateral angle of the thalamus, note a small grey mass (see Fig. 208); it is the *tail of the caudate nucleus* descending into the roof of the inferior horn of the lateral ventricle; and, close to its medial side, there is the divided *stria semicircularis*, which is so slender that it may not be easy to detect it.

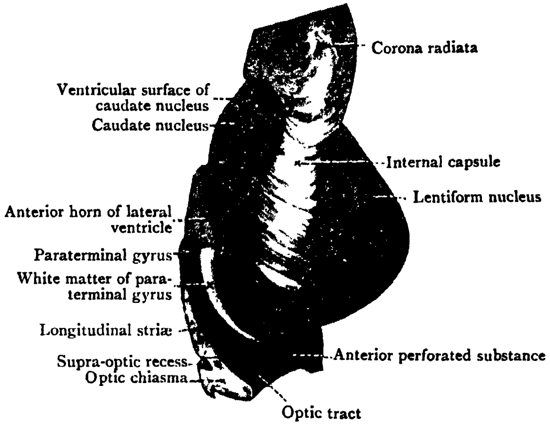


FIG. 211.—Coronal Section through Anterior Perforated Substance and anterior part of Corpus Striatum, after the dissection represented in Fig. 219 had been made on the left hemisphere.

Examine next the vertical transverse sections and note:—

In the **first section** (which passes through the posterior part of the frontal lobe) the head of the caudate nucleus and the anterior part of the lentiform nucleus are fusing together below and lateral to the anterior horn of the lateral ventricle (see Fig. 210). As they blend, a striate appearance is produced by the intermingling of a large number of grey and white striæ which pass between the two grey masses. It is because of the union and because of the striate appearance in the region of the union that the caudate nucleus and the lentiform nucleus are spoken of, together, as the corpus striatum.

In the **second section** (which passes through the anterior perforated substance), the lower surface of the anterior parts of the lentiform and caudate nuclei are blending with the anterior perforated substance (Fig. 211).

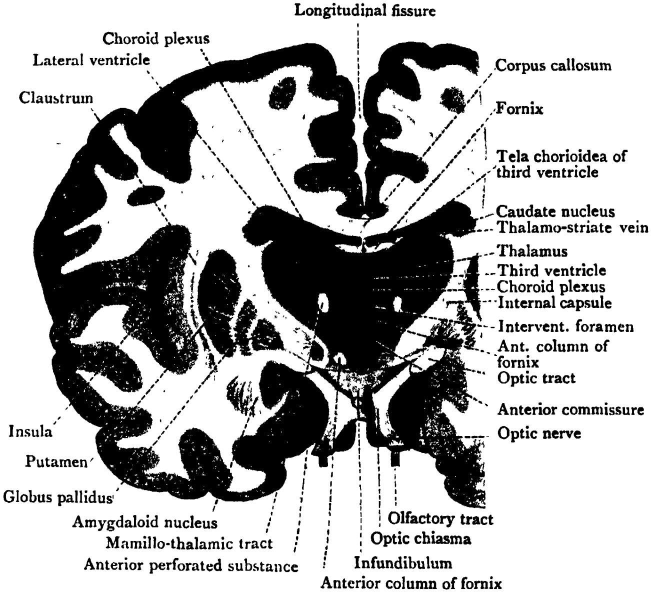


FIG. 212.—Coronal Section through Cerebral Hemisphere in such a plane as to cut the three parts of Lentiform Nucleus; the posterior cut surface of the anterior part of the hemisphere is depicted.

In the **third section** (which passes between the tuber cinereum and the mamillary body, and is in front of the inferior horn of the ventricle) the main features seen in the horizontal section are again visible, but there are some modifications due to the different plane of section (Fig. 212). The points to be noted are—(*a*) The caudate nucleus, the stria semicircularis and the lateral part of the upper surface of the thalamus are in the floor of the central part of the lateral ventricle. (*b*) In the substance of the thalamus a divided white bundle is seen ; it is the mamillo-thalamic tract. (*c*) A divided white bundle is seen also in the substance of the hypothalamus; it is the anterior column of the fornix. (*d*) Lateral to the thalamus there is the lentiform nucleus, clearly divided into its three parts. (*e*) The internal capsule separates the lentiform nucleus from the thalamus. (*f*) The internal capsule is continuous with a white mass between the upper margin of the lentiform nucleus and the body of the caudate nucleus ; that is the base of the *corona radiata*, from which fibres begin to diverge towards all the adjacent parts of the cortex. (*g*) The optic tract (cut) is seen immediately below and medial to the lentiform nucleus. (*h*) The anterior part of the junction between the internal capsule and the basis pedunculi is seen

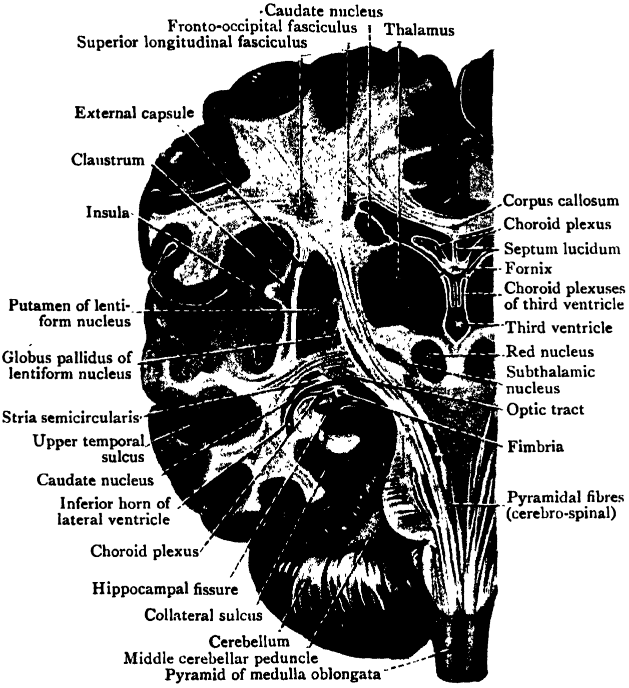


FIG. 213.—Oblique Section to show the course of Cerebro-Spinal Fibres.

immediately above and medial to the optic tract. (*i*) Fibres from that junction pass laterally below the lentiform nucleus and blend with the white laminæ in the lentiform nucleus and with the external capsule, which is the white strip on the lateral surface of the lentiform nucleus. (*j*) A portion of the amygdaloid nucleus is seen a little below the lentiform nucleus, in the substance of the uncus. (*k*) The grey strip lateral to the external capsule is the claustrum ; beyond that, there is the white and grey matter of the insula ; and finally, the opercula (if they have not been removed).

In the **fourth section**—(*a*) The internal capsule is directly continuous, below, with the basis pedunculi, and, above, with the corona radiata. (*b*) The thalamus rests upon the hypothalamic region, which is directly continuous with the tegmentum of the mid-brain. (*c*) In the hypothalamic region, two additional nodules of grey matter are easily recognisable. The medial and more rounded of the two is the upper part of the *red nucleus*, which extends downwards into the upper half of the tegmentum. The more lateral is the *subthalamic nucleus*, which is limited to the posterior part of the hypothalamic region. (*d*) The lentiform nucleus now lies above the roof of the inferior horn of the lateral ventricle, from which it is separated by a layer of transversely directed fibres (Fig. 213). (*e*) The lentiform nucleus is not now so distinctly divided into three segments.

When the examination of the surface appearances of the sections is completed, the dissector will study, in more detail, the structures seen in various parts of their extent in the series of sections. Replace the sections in their proper relations to one another, and separate them again, when necessary, and so confirm the majority of the statements contained in the following accounts of the individual structures.

Corpus Striatum.—The corpus striatum is a mass of grey matter embedded in the base of the hemisphere. It is partially divided into two nuclei named the *caudate nucleus* and the *lentiform nucleus*—the main part of the caudate nucleus lying above and medial to the lentiform nucleus. The antero-inferior portions of the two nuclei are blended together ; the remaining portions are separated from each other by a thick layer of white matter. This white matter is the internal capsule at its junction with the base or root of the corona radiata. It does not wholly separate the nuclei, for a series of bands of grey matter pass through it at fairly close intervals from the one nucleus to the other.

The **caudate nucleus** is a comma-shaped mass, and has a head, a body and a long tail. The *head*—wide, thick and convex—lies in the lateral wall of the anterior horn of the lateral ventricle. The *body*—much thinner and narrower—runs backwards in the lateral part of the floor of the central portion of the lateral ventricle. The *tail*—thin and flat—turns downwards, and then runs forwards in the roof of the inferior horn to end in the amygdaloid nucleus.

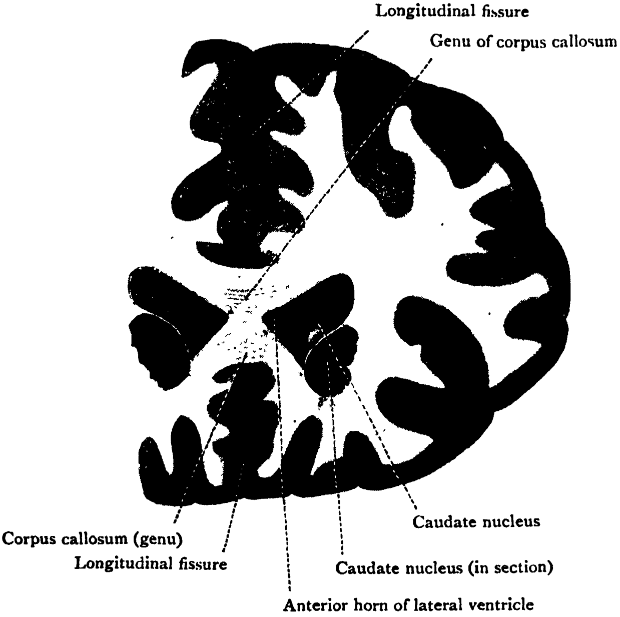


FIG. 214.—Coronal Section in front of Lentiform Nucleus. The posterior surface of the anterior part is depicted.

The whole of the *superficial surface* of the caudate nucleus is covered with ependyma. The lower part of the *deep surface* of the head is fused with the anterior part of the lentiform nucleus; the rest of the head lies on the internal capsule and the base of the corona radiata; and the deep surface of the body and tail lie on the base of the corona. The upper part of the head and the lateral border of the body are separated from the corona by a thin strand of long association fibres which runs from the frontal lobe to the occipital lobe and is therefore called the **fronto-occipital bundle.** It may be noted also that the lower part of the head lies on the white matter of the orbital gyri (Fig. 214), and, behind that, is connected by grey matter with the anterior perforated substance (Fig. 211).

The **lentiform nucleus** is a compact mass of considerable size, and has three surfaces—lateral, medial and inferior. It does not reach so high a level as the caudate nucleus, nor does it reach so far backwards and forwards.

The *lateral surface* is convex and smooth, but its lower part is grooved by the lateral striate vessels before they sink into its substance. It is completely covered by a thin lamina of white matter called the external capsule.

The *medial surface*, when seen in horizontal section, is highly convex or angled. Its antero-inferior part is fused with the lower part of the head of the caudate nucleus. The rest of it is closely applied to the internal capsule, which separates it from the head of the caudate nucleus and from the thalamus—the angle of the surface being opposite the interval between the caudate nucleus and the thalamus.

The *inferior surface* is deeply grooved by the anterior commissure as it passes laterally and backwards to reach the temporal lobe. The anterior part of the surface is fused with the anterior perforated substance. Behind that, it lies on the white matter of the temporal lobe and is partly continuous with the amygdaloid nucleus ; and, still farther back, it rests on the white matter that overlies the roof of the inferior horn (Figs. 211, 212, 213).

Immediately above the upper border of the lentiform nucleus there is a thick bundle of long association fibres called the **superior longitudinal fasciculus** (Fig. 213). The bundle begins in the frontal lobe, runs backwards in the root of the fronto-parietal operculum, and splits into two parts, one of which runs on into the occipital lobe, while the other curves downwards into the temporal lobe.

The lentiform nucleus is divided into three parts by two thin vertical sheets of white matter. The lateral part is very much the largest and is called the *putamen* ; it is the putamen only which is connected with the caudate nucleus. The medial two parts are much paler, and both of them are included under one name—the *globus pallidus*

The corpus striatum is a very old part of the hemisphere (the globus pallidus being the oldest part of it). It is a higher centre concerned with the regulation of muscular tone and the automatic control of muscular movements. The putamen and the caudate nucleus send fibres to the globus pallidus, which sends fibres to the red nucleus and other lower nuclei concerned with muscular tone and movements ; and a reflex mechanism is established by sensory fibres that pass from the thalamus to the putamen and the caudate nucleus. Although the cerebral cortex controls all parts of the nervous system, yet fibres from the cortex to the corpus striatum have not been demonstrated.

Claustrum and Amygdaloid Nucleus.—These basal nuclei also are early evolved parts of the brain ; but their functions and the connexions established by the fibres that arise and end in them are obscure.

The functions and fibre-connexions of the **claustrum** are unknown ; and it is possibly a detached sheet of grey matter of the insula, which is an old part of the cortex whose function also is unknown. The claustrum is a thin plate of grey matter which lies between the external capsule and the white matter of the insula, and is of the same length and height as the insula. Its medial surface is relatively smooth. Its lateral surface is scalloped—the elevations and depressions corresponding with the gyri and sulci of the insula. Its lower border, which is its broadest part, is fused, anteriorly, with the anterior perforated substance and the amygdaloid nucleus.

The **amygdaloid nucleus** lies partly in the anterior end of the roof of the inferior horn and partly in the uncus, in front of the end of the horn. It is continuous :—with the claustrum ; with the tail of the caudate nucleus ; with the antero-inferior part of the putamen of the lentiform nucleus ; with the anterior perforated substance ; and with the grey matter of the uncus. It gives rise to the fibres of the stria semicircularis ; and, lying in the uncus, it is probably part of the olfactory apparatus, which has more intricate and perplexing nervous pathways and connexions than any of the other organs of special sense.

The **stria semicircularis** is a slender band of fibres that arises in the amygdaloid nucleus. It runs backwards in the roof of the inferior horn along the medial margin of the tail of the caudate nucleus ; bends upwards into the central part of the lateral ventricle and runs forwards in its floor between the thalamus and the body of the caudate nucleus. At the interventricular foramen, it joins the anterior column of the fornix, and descends with it to the base of the brain, where it ends in the anterior perforated substance.

Nuclei and Connexions of Thalamus.—The thalamus is divided into three nuclei by a vertical sheet of white matter which is Y-shaped in horizontal sections, with the stem directed backwards. The nuclei are named *anterior*, *medial* and *ventro-lateral.* The ventro-lateral nucleus is much the largest, and includes the whole pulvinar. Like the basal nuclei, the thalamus is a very old part of the brain, and the anterior and medial nuclei are the oldest parts of it. It is a great sensory centre, and is connected with the grey matter of all parts of the central nervous system—spinal cord as well as brain.

The chief *afferent* fibres received by it are:—(1) the spino-thalamic tracts and the medial lemniscus, which bring the impressions of ordinary sensations to it from the opposite half of the body; (2) the mamillo-thalamic tract, which brings olfactory impressions; (3) the visual fibres of the optic tract, which end in the lateral geniculate body; (4) auditory fibres from the brain-stem, which end in the medial geniculate body. Besides those, it receives afferent fibres from the cerebral cortex, which exercises supervision over it; they descend to it through the corona radiata and the internal capsule. The *efferent* fibres are chiefly those which stream in multitudes out of its lateral surface. They pass into the internal capsule, and thence to the basal nuclei, and, in the corona radiata, to all parts of the cortex. The best known of these fibres are those that convey the impressions of ordinary sensation to the post-central gyrus and the paracentral lobule, and those that form part of the optic and auditory radiations.

Optic Radiation.—The optic radiation is a wide sheet of fibres that lies in the midst of the white matter of the occipital lobe, a little lateral to the posterior horn of the ventricle. When traced backwards it spreads out, and its fibres are connected with the centre for sight in the occipital lobe in relation to the calcarine and post-calcarine sulci. Traced forwards, the fibres club together and enter the most posterior part of the internal capsule, whence they proceed to the lower visual centres. Fibres run both ways in it:—(1) Fibres pass backwards in it from the lateral geniculate body to the occipital cortex; (2) fibres run forwards from the occipital cortex to the lateral geniculate body, to the pulvinar, and to the superior corpus quadrigeminum—whence fibres pass to the nuclei of the nerves that supply the muscles of the eyeball.

If the specimen of brain in hand is fairly white, refresh the surface of the white matter at the lateral side of the posterior horn by removing an exceedingly thin slice, and examine the surface. Slight differences in the density and texture of the layers of white matter may be detected. The thin white layer next to the ependyma of the lateral wall of the horn is the tapetum of the corpus callosum. The layer lateral to that is the *optic radiation*. The white matter immediately lateral to the radiation is part of the inferior longitudinal fasciculus (p. 489).

Auditory Radiation.—The fibres of the group to which this name is given arise in the medial geniculate body. They pass into the most posterior part of the internal capsule—which is close to the medial geniculate body—and at once leave the capsule and spread out to form the radiation. In the radiation, they run in a lateral direction between the lentiform nucleus and the roof of the inferior horn of the lateral ventricle to reach the cortex of the temporal lobe, where they end in the centre for hearing.

Internal Capsule.—The dissectors should now study the internal capsule both in the vertical sections of the left hemisphere and the horizontal section of the right.

The internal capsule is a relatively thick lamina of white matter made up of itinerant fibres by which the cerebral cortex establishes connexions with the grey matter in all the other parts of the central nervous system.

It is continuous superiorly with the corona radiata, and inferiorly with the basis pedunculi.

It separates the lentiform nucleus from the thalamus and the head of the caudate nucleus. It is moulded upon the angled, medial surface of the lentiform nucleus, and, therefore, itself presents a bend or angle directed medially when seen in horizontal section. The bend is called the *genu* of the internal capsule, and lies between the lentiform nucleus and the stria semicircularis. The portion in front of the genu is known as the *anterior limb* of the capsule; it separates the lentiform nucleus from the head of the caudate nucleus. The part behind the genu is the *posterior limb*. It lies on the lateral surface of the thalamus and separates the thalamus from the lentiform nucleus. But the thalamus extends farther back than the lentiform nucleus does; the posterior limb has therefore a *lentiform part* and a *retrolentiform part*. The anterior limb is the thinnest part, and is greatly interrupted by the grey matter which connects the lentiform nucleus with the head of the caudate nucleus.

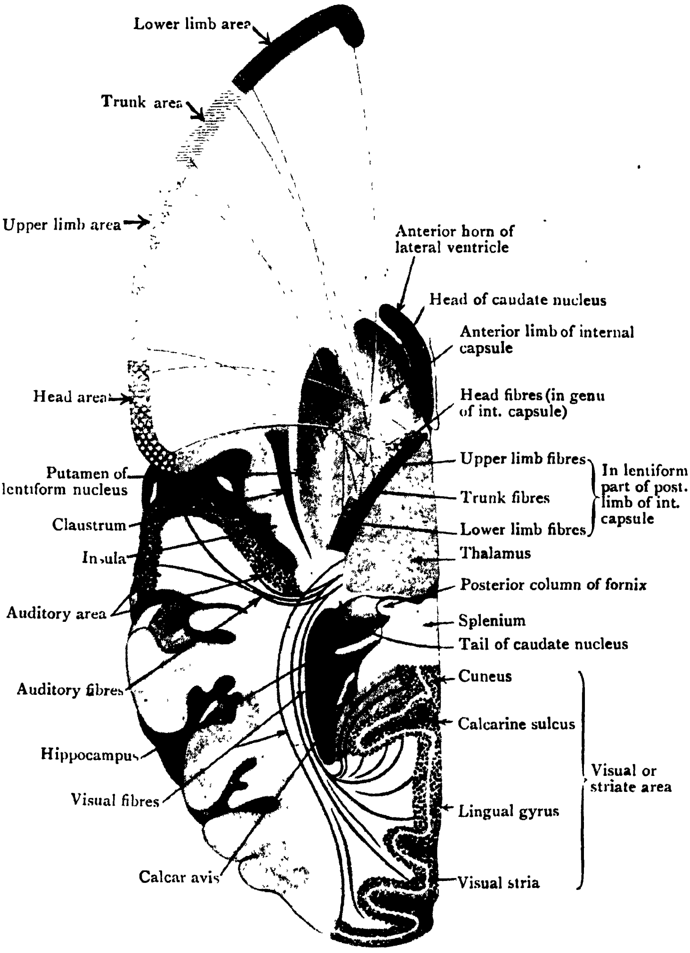


FIG. 215.—Diagram of Motor, Auditory and Visual Areas of Left Hemisphere and their Relations to Internal Capsule.

The internal capsule and the auditory and visual areas are seen in horizontal section; while the motor area is supposed to be in coronal section.

The area of ordinary sensation is not shown; but the position of the ordinary sensory fibres in the internal capsule is shown in blue.

Constituent Fibres of Internal Capsule.—**Cortico-pontine fibres** (p. 465) lie in all parts of the internal capsule.

The anterior limb is largely composed of fibres that connect the corpus striatum with other parts and of fibres that pass from the thalamus to the anterior part of the cortex.

The best known components of the capsule are found in the genu and posterior limb of the capsule. They are the motor fibres and ordinary sensory fibres for the opposite half of the body; and the optic and auditory fibres.

The **motor fibres** lie in the genu and the lentiform part of the internal capsule, and are arranged in order from before backwards—head, upper limb, trunk and lower limb. The **sensory fibres** for the several parts of the body occupy corresponding positions; but, since they are streaming out of the thalamus, they are at first medial to the motor fibres. Sensation is therefore less interfered with than motion in a paralysis resulting from cerebral hæmorrhage, for the ruptured artery is one of the striate arteries (p. 407), and lies in the lentiform nucleus—that is, lateral to the capsule—and therefore farther away from the sensory fibres than from the motor fibres. The artery is well forward in the nucleus, and the paralysis is more marked therefore in the upper limb than in the lower limb, whose fibres lie farther back in the capsule.

The retro-lentiform part is occupied chiefly by the fibres of the optic and auditory radiations—*i.e.* the fibres associated with the special senses of sight and hearing. They pass between the higher centres in the cortex and the lower centres in the thalamus and mid-brain; through these lower centres, they are connected with the eye and ear of both sides. These radiations have been considered already (pp. 480, 481).

External Capsule.—This thin white lamina, which is composed chiefly of association fibres, intervenes between the claustrum and the lentiform nucleus. It merges into the corona radiata at the ends and upper border of the lentiform nucleus, while, inferiorly, it blends with the white matter that separates the lentiform nucleus from the roof of the inferior horn of the lateral ventricle.

FUNCTIONS OF CEREBRAL CORTEX

If the dissectors have a second specimen of the brain at their disposal, they should use the left half for the revision of the cerebral cortex and its membranes and vessels (and for the dissection which follows that revision), because the speech centre is in the left cortex. If they are restricted to one specimen, and have adhered to the directions, the right half of the cerebrum has been retained for revision and dissection, but has been divided by a horizontal cut.

Place the two parts together; revise the *membranes* and *blood-vessels*, and then remove them. Refresh your memory regarding the characters and relations of the *poles*, *borders* and *surfaces*; and then, on each surface, identify the *sulci* and *gyri* that have been named in the previous account. Note especially the gyri whose functions are known—that is, those in which the centres for motion, sensation, sight, hearing and smell are lodged.

Cortical Areas (Figs. 179, 216).—If the brain is in good condition, with well-marked distinction between the grey and the white matter, make a cut in the visual area, and look for the visual stria (p. 433). Make cuts also in the motor and sensory areas, and note that the grey matter is thicker in the motor area than in the sensory area. In this way it will be seen that differences in structure of cortical areas of different function can be detected in sections even by the naked eye. When specially prepared sections of the cortex are examined under the microscope, remarkable variations of the histological characters are observed in different parts, by means of which the cortex can be mapped out into a large number of small areas exhibiting different structure.

The full significance of these variations is not known, and it is therefore impossible to allot functions to all those small areas with precision. But experimental and pathological evidence (with which anatomical structure and connexions are in accord) has enabled us to localise functions in a general way in certain larger areas which have definite relations to the principal sulci. Thus, it is known that some parts are centres for the reception and appreciation of sensory impressions (both ordinary and special) and that others are concerned with the control of movements and the discharge of motor impulses.

Certain parts of these larger areas have been briefly mentioned already; and the student, having reviewed the whole surface, is now in a position to appreciate more fully their relations to each other and to other parts of the cortex.

The **motor area** occupies the anterior wall of the central sulcus, and extends on to the free surface of the pre-central gyrus. The portion of the free surface occupied is very narrow inferiorly, but, as it is traced upwards, it widens (owing to the diminishing depth of the central sulcus), till, at the top, it occupies nearly the whole breadth of the gyrus, and extends over the margin to occupy a large part of the paracentral lobule. This area contains the centres for *individual movements*, such as bending one joint; and in it the opposite half of the body is represented in an inverted order, beginning with the centres for the movements of the lower limb in the paracentral lobule and adjacent part of the pre-central gyrus. Note that the centres are for individual *movements* not individual *muscles*.

The **psycho-motor area** occupies the adjoining parts of the paracentral lobule and the pre-central and frontal gyri, and is an essential adjunct to the motor area. It is the centre for the initiation and control of the combined individual movements necessary in the *performance of an act*, such as writing a word. Most acts are brought about by simultaneous and successive movements of different parts of the body, and their centres are scattered in the area. But certain acts involve only the movements of parts that are close together; their centres are more localised, and the position of some of them has been ascertained. For example, the centres for the conjugate movements of the eyes and associated movements of the head have been located in the posterior part of the middle frontal gyrus; and, in right-handed people, the psycho-motor area of the left hemisphere extends forwards as far as the horizontal anterior ramus of the lateral sulcus to include a psycho-motor centre for speech adjacent to the motor centres for the larynx, tongue and lips at the lower part of the motor area.

The remainder of the frontal lobe, including the orbital surface and the medial frontal gyrus, is one of the " silent " areas, for lesions of it have not produced easily recognised disabilities. But it is generally supposed to be the highest cortical area, connected by association fibres with all other areas, and to be the seat of the intellectual processes that imply attention, concentration and ideation.

The **sensory area** for ordinary sensation occupies the posterior wall of the central sulcus, the adjacent edge of the free surface of the post-central gyrus and part of the paracentral lobule behind the central sulcus. As in the motor area, the opposite half of the body is represented in the inverted order ; and the motor and sensory centres for the same part therefore adjoin each other. The **psycho-sensory area** occupies the rest of the post-central gyrus and the most posterior part of the paracentral lobule. Sensations are received in the sensory area, and are recognised there ; they are interpreted in the psycho-sensory area in the light of past experience.

The **visual area** or **striate area** is below the calcarine sulcus and on both sides of the post-calcarine sulcus. If the post-calcarine sulcus extends on to the supero-lateral surface of the hemisphere, the visual area is carried with it, and is limited there by the sulcus lunatus. The **psycho-visual area** includes nearly all the rest of the occipital part of the hemisphere. Sensations produced by the effect of light on the retina are received and appreciated in the visual area, and interpreted in the psycho-visual.

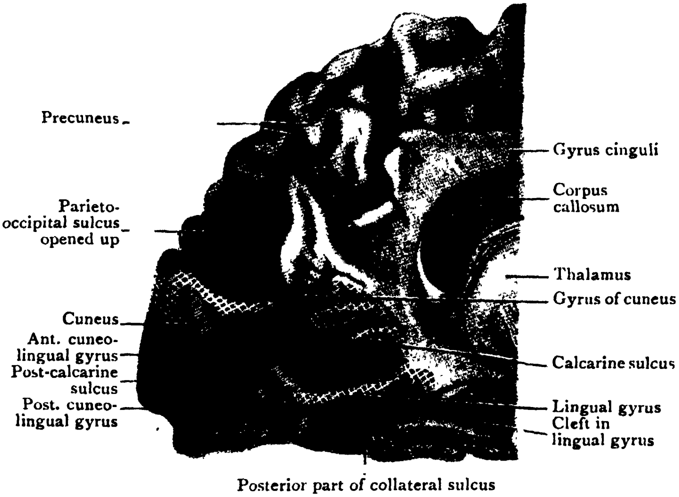


FIG. 216.—Posterior part of Medial Surface of Left Hemisphere. The *visual area* is coloured uniform blue ; the *psycho-visual area* is dotted. The Parieto-Occipital and the Calcarine Sulci are fully opened up to show the deep gyri within them.

The **auditory area** occupies the gyri on the hidden surface of the temporal operculum and the adjoining part of the superior temporal gyrus, immediately below the post-central gyrus. The **psycho-auditory area** occupies most of the rest of the superior temporal gyrus and hidden surface of the operculum. Sounds are received and appreciated in the auditory area, and interpreted in the psycho-auditory. The regions occupied by these areas are of special importance in the left hemisphere owing to their connexion with the centre for speech by means of association fibres which pass between them through the white matter subjacent to the insula.

The **olfactory area** is situated in the uncus and hippocampus and associated parts of the rhinencephalon. The psycho-olfactory area may be in the hippocampal gyrus, in which gustatory sensations also may be interpreted, for taste is closely allied to smell; and it is possible that the gyri near and continuous with the hippocampal gyrus also function in the same way.

The **parietal area** includes the precuneus and all the parietal lobe behind the post-central sulcus, and is a higher psychic area for all the senses—ordinary and special. Examine its boundaries and note that it is surrounded by the sensory, auditory and visual psychic areas. It is connected with them by association fibres, and correlates the interpretations of different sensory impressions received from material things.

The "**silent areas**" are those whose functions have not yet been discovered. The greater part of the frontal lobe is included in them, and was, indeed, the first to be given the name " silent area ".

DEEP DISSECTION OF HEMISPHERE

The dissectors will now undertake a final dissection of the cerebral hemisphere from the lateral side during which they will expose: (1) certain of the bundles of long association fibres, (2) the external capsule, (3) the lateral portion of the anterior commissure, (4) the lateral striate arteries, (5) the lentiform nucleus, (6) the internal capsule and a portion of the corona radiata. This dissection requires the greatest care and attention, and considerable patience. It is carried out mainly by the use of forceps—both blunt-pointed and sharp-pointed. The knife is to be used only when the dissectors are quite sure that they are not cutting away anything that belongs to a subsequent stage of the dissection.

For this dissection, an undamaged half of the cerebrum should, if possible, be procured. But if the dissectors have only one specimen, they may use the right hemisphere, which has been divided into upper and lower parts. Place the two parts together accurately, and retain them in position by three long pins thrust vertically through them—one near each end and one near the medial surface at its middle.

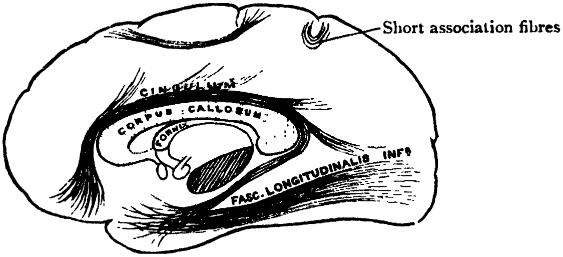


FIG. 217.—Diagram of Association Bundles (medial aspect of hemisphere).

(Founded on the drawings of Dejerine)

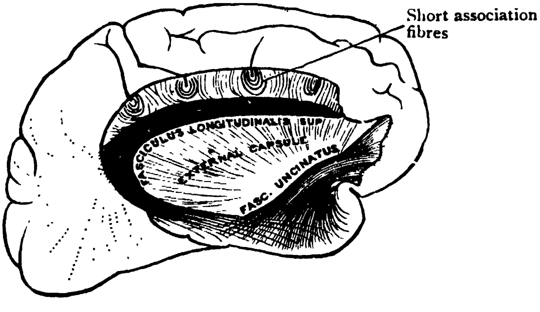


FIG. 218.—Diagram of Association Bundles (lateral aspect of hemisphere).

(Founded on the drawings of Dejerine)

***Dissection.*—Remove each of the opercula—all except their roots—and then proceed to expose three of the bundles of long association fibres, namely, the fasciculus uncinatus and the superior and inferior longitudinal fasciculi.**

With a blunt-pointed pair of forceps, remove the grey matter from what remains of the lateral surface of the temporal lobe

and the corresponding part of the occipital lobe. Note the arrangement of the *short association fibres* (p. 431); remove them carefully, and expose the *inferior longitudinal bundle*, which extends from the occipital pole to the temporal pole.

Turn to the bottom of the stem of the lateral sulcus, and scrape away the grey matter of the limen insulæ (p. 429). The grey matter is very thin; you soon come upon a fairly thick round bundle of white matter which hooks round the bottom of the sulcus: that is the *fasciculus uncinatus* (p. 429). Trace it into the temporal lobe and towards the orbital surface; but be careful not to damage the insula.

Pass now to the region immediately above the insula. Move the point of the forceps backwards and forwards through the white matter of the root of the fronto-parietal operculum till some antero-posterior fibres are found. These are the superficial fibres of the thick tract called the *superior longitudinal bundle* (p. 478). Expose the whole bundle in this situation, and trace it forwards and backwards. Its surface is very uneven, owing to the broken ends of the multitudes of fibres that connect it with overlying gyri. At the posterior end of the posterior ramus of the lateral sulcus, the bundle spreads out and its fibres diverge widely. Trace the smaller part into the occipital lobe, and the larger part first downwards and then forwards in the temporal lobe.

Inferior Longitudinal Bundle.—This is a bundle of long association fibres of considerable vertical width. It lies deeply in the white matter of the lower part of the supero-lateral surface of the hemisphere, extending from the occipital pole to the temporal pole.

The other fasciculi of long association fibres are briefly described on pp. 429, 435, 478. Read the short accounts of them on the pages cited, and then proceed to expose the lentiform nucleus.

4 [illegible]

***Dissection.*—Remove first the grey matter and then the white matter of the insula. The *claustrum* (p. 479) is then exposed. It may be disclosed as an unbroken sheet; but, usually, only patches of it are left—the rest having come away with the white matter. Remove these patches, and the *external capsule* (p. 483) will be fully exposed—a smooth, glistening sheet of white matter, bulged laterally by the convex surface of the lentiform nucleus. As the lower part of the claustrum is removed, a round bundle—the *anterior commissure*—may be met with as it emerges from the lower surface of the lentiform nucleus and passes into the temporal lobe.**

Strip the external capsule piecemeal off the *lentiform nucleus*, which will be recognised by its grey colour. Be careful at the upper part, where the white matter does not strip off easily, and the nucleus is liable to be injured as its upper margin is defined. At the lower part of the nucleus, look (1) for the *lateral striate vessels* (p. 407), which lie in grooves on its surface, and (2) for the *anterior commissure*, if it has not been found already. Leave the vessels in the meantime; trace the anterior commissure into the temporal lobe, where it spreads out as a thin sheet.

The commissure will not be wholly exposed till the lentiform nucleus is removed; but it is convenient to consider its relations now.

Anterior Commissure.—This bundle is complementary to the corpus callosum. It connects the lower and anterior parts of the two temporal lobes—the only parts of the cortex of the two hemispheres that are not united by fibres of the corpus callosum. The commissure has the shape of a cupid's bow—except at the outspread ends—and its fibres are twisted so that it resembles a piece of thick string. Its *median part* lies in the anterior wall of the third ventricle in front of the anterior columns of the fornix, and has been seen already in the interval between those two columns as they diverge from each other Each *lateral part* sinks into the substance of the hemisphere, passes above the anterior perforated substance and the amygdaloid nucleus, and reaches the white matter of the temporal lobe, where it spreads out like a fan. At first, it runs laterally, with a slight inclination forwards, below the head of the caudate nucleus and the anterior part of the internal capsule. It then enters a deep groove on the

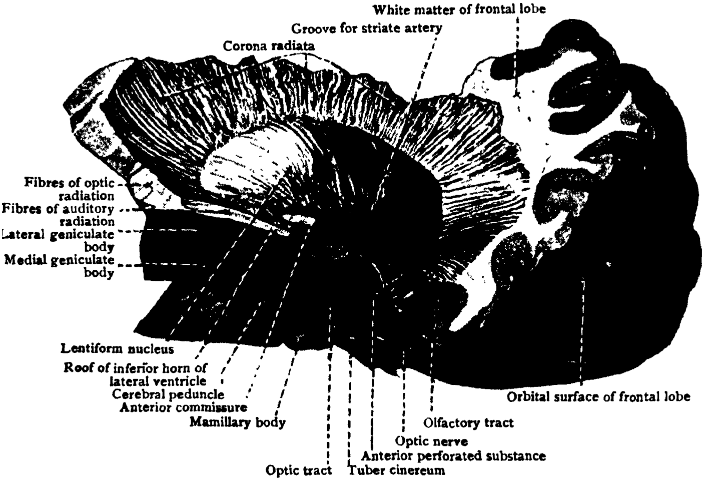

White matter of frontal lobe
Groove for striate artery
Corona radiata
Fibres of optic radiation
Fibres of auditory radiation
Lateral geniculate body
Medial geniculate body
Lentiform nucleus
Roof of inferior horn of lateral ventricle
Cerebral peduncle
Anterior commissure
Mamillary body
Optic tract
Tuber cinereum
Anterior perforated substance
Optic nerve
Olfactory tract
Orbital surface of frontal lobe

FIG. 219.—Dissection of Right Lentiform Nucleus and Corona Radiata from the lateral side.

lower surface of the lentiform nucleus in which it runs backwards and laterally. At the present stage of the dissection, it is found emerging from that groove and spreading out in the temporal lobe. The sublenticular part will be exposed in a subsequent stage.

Dissection.—Divide the anterior commissure near the lentiform nucleus. Trace the *lateral striate vessels* to their entrance into the brain at the anterior perforated substance, with which the lentiform nucleus is partly fused ; and define the lower margin and the ends of the lentiform nucleus. To do this, you will find it necessary to remove part of the fasciculus uncinatus, the anterior part of the hippocampal gyrus and the anterior part of what remains of the temporal lobe.

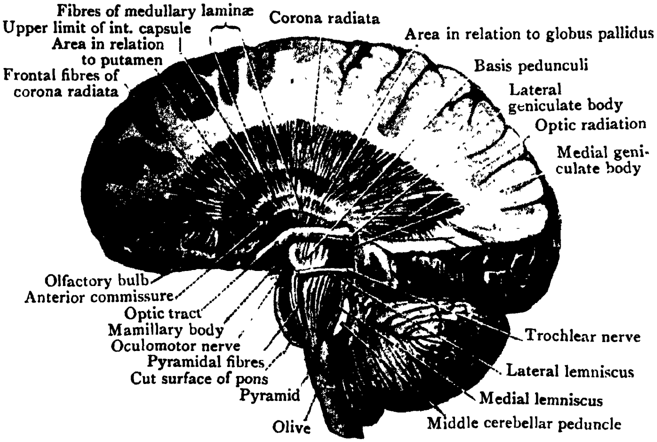


FIG. 220.—Dissection of Internal Capsule and Pyramidal Fibres.

Revise the position and relations of the lentiform nucleus (p. 478), and the origin, course and destination of the striate arteries, and then proceed to expose the internal capsule and the corona radiata.

Dissection.—To expose the internal capsule, the dissector requires only to remove the lentiform nucleus. If you are doing the dissection for the *second* time, try to remove the lentiform nucleus in one piece. To do this, pass the handle of the knife carefully downwards between the nucleus and the internal capsule, and then, with forceps and handle of knife, set free the lower surface of the nucleus—taking care to disengage the *anterior commissure* from the groove on that surface. If you

are doing the dissection for the *first* time, it will ensure a better exposure of the internal capsule if you sacrifice the nucleus and take it away piecemeal. In doing so, be careful at the anterior part, for that part of the capsule is thin, and is so broken up by the grey laminæ which connect the lentiform and caudate nuclei that it is liable to be taken away with the lentiform nucleus. Disengage the *anterior commissure* from the lower surface of the nucleus, and preserve it. Leave the *optic tract* in place. It is close to the lower surface of the lentiform nucleus, and it marks the junction of the internal capsule and the basis pedunculi.

The ends and upper margin of the lentiform nucleus mark the junction of the capsule with the base of the corona radiata. Trace the corona radiata forwards and upwards and backwards ; trace it also laterally from below the hinder part of the nucleus into what remains of the temporal lobe—removing the overlying fibres of the longitudinal bundles. Superiorly, the corona radiata cannot be traced far, for it soon intersects the corpus callosum ; but it can be traced farther in the other directions.

The corona radiata, internal capsule and basis pedunculi can now be seen in continuity from the lateral side.

When the basis pedunculi was examined, it was noted that its fibres are slightly twisted. It can be seen now that the twisting is to some extent continued into the capsule. Note also that the medial and lateral parts of the basis are continuous respectively with the anterior and posterior parts of the capsule ; the cortico-pontine fibres of the frontal lobe pass therefore into the medial part of the basis, and those from the occipital and temporal lobes into the lateral part.

If the lentiform nucleus has been completely removed, the ***lateral surface*** of the **internal capsule** is seen to be concave or angled in conformity with the shape of the medial surface of the lentiform nucleus—the angle or ***genu*** being above the anterior commissure. The surface of the capsule is crossed by a narrow, antero-posterior, curved ridge consisting of the broken ends of the fibres of the white lamina that separates the putamen from the globus pallidus. The part of the capsule above the ridge is related to the putamen, and it is radially ribbed by the grey laminæ that connect the putamen with the caudate nucleus. The lower area is related to the globus pallidus ; and, if the brain was well hardened, this area is subdivided by a slight ridge that marks the position of the white lamina of the globus pallidus.

The ***anterior border*** of the internal capsule, after a short ascent, plunges horizontally forwards above the anterior commissure and above the line where the lentiform and caudate nuclei fuse with each other and with the anterior perforated substance.

The ***posterior border*** is thick and extremely short—no longer than the width of the stria semicircularis, which covers the border as it bends round from the floor of the central part of the lateral ventricle into the roof of the inferior horn. The fibres that form the posterior or retrolentiform part of the internal capsule leave the capsule therefore directly after they enter it. They include the optic and auditory fibres, which form the optic and auditory radiations ; and these radiations are included in the parts of the corona radiata that spread into the occipital lobe and the temporal lobe—the centre for sight being in the occipital lobe and the centre for hearing in the temporal lobe.

The dissectors will now proceed to the examination of the hind-brain.

HIND-BRAIN

The parts of the hind-brain are the *pons*, the *medulla oblongata* and the *cerebellum*.

Medulla Oblongata.—The medulla oblongata is the continuation of the spinal cord into the brain. It may be reckoned as beginning at the level of the foramen magnum, whence it proceeds almost vertically upwards (Fig. 204) to end at the lower border of the pons. It is rather more than one inch long; and, at first, its girth is similar to that of the spinal cord, but it rapidly expands as it approaches the pons. The expanded part was once known as "the bulb of the spinal marrow," and the name *bulb* is retained in certain compounds —*e.g.*, *bulbo-spinal tract*, *bulbar paralysis*.

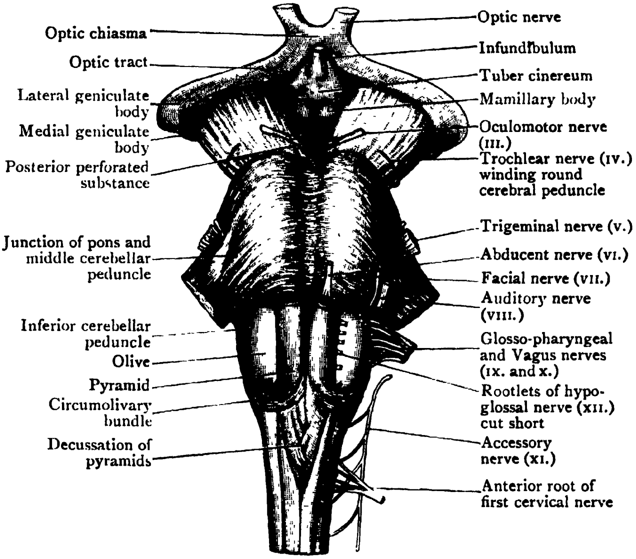


FIG. 221.—Anterior Surface of Medulla Oblongata, Pons, and Mid-Brain of a full-time Fœtus.

The anterior surface of the medulla oblongata is related to the basilar portion of the occipital bone, and its posterior part is sunk into the lower part of the anterior notch of the cerebellum. Its upper half shares in bounding the fourth ventricle of the brain, but its lower half is tunnelled by a *central canal* which is continuous inferiorly with the central canal of the spinal cord, and superiorly with the fourth ventricle.

Median Fissures.—The bilateral construction of the medulla oblongata is indicated on the surface by an anterior and a posterior median fissure.

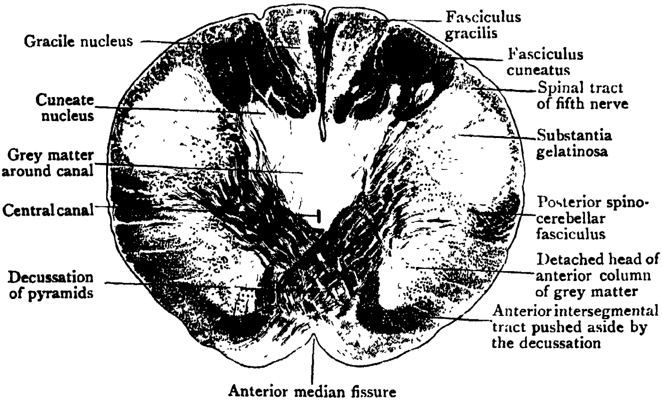

Fasciculus gracilis
Gracile nucleus
Fasciculus cuneatus
Spinal tract of fifth nerve
Cuneate nucleus
Substantia gelatinosa
Grey matter around canal
Central canal
Posterior spino-cerebellar fasciculus
Detached head of anterior column of grey matter
Decussation of pyramids
Anterior intersegmental tract pushed aside by the decussation
Anterior median fissure

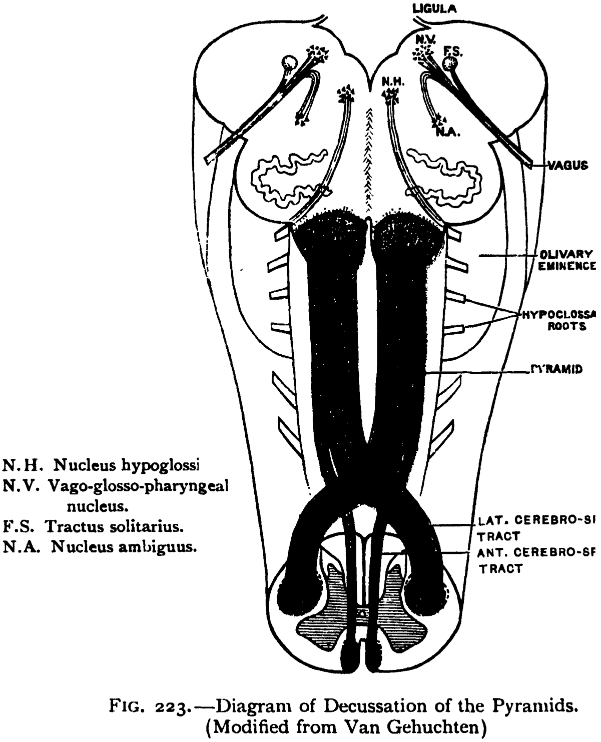
FIG. 222.—Transverse Section through lower end of Medulla Oblongata of a full-time Fœtus, treated by the Weigert-Pal method. The grey matter is therefore bleached white; whilst the medullated tracts are black.

The *anterior median fissure* is interrupted, at the lower part of the medulla oblongata, by the decussation of the pyramids (p. 377).

The *posterior median fissure* exists only in the lower half of the medulla oblongata. For the central canal, as it is traced upwards, approaches the back of the medulla, and, half way up, opens into the fourth ventricle; and the lips of the fissure are thrust apart to become continuous with the lateral margins of the ventricle.

Surface Characters.—The surface of each half of the medulla oblongata should now be studied. It is well, however, to defer the examination of the part of it seen in the floor of the fourth ventricle till a later period.

The dissector has already noticed two linear rows of nerve rootlets attached to each half of the medulla oblongata. The *anterior row* consists of the rootlets of the hypoglossal nerve and the uppermost bundles of the anterior root of the first cervical nerve. They are in line with the anterior roots of the other spinal nerves ; and they emerge along the bottom of a more or less distinct groove. The *posterior row* is formed, from below upwards, of the rootlets of the accessory, vagus and glosso-pharyngeal nerves. They are in series with the posterior roots of the spinal nerves, and are attached to the floor of an indistinct, vertical groove whose upper part is a little behind the olive.



N.H. Nucleus hypoglossi
N.V. Vago-glosso-pharyngeal nucleus.
F.S. Tractus solitarius.
N.A. Nucleus ambiguus.

FIG. 223.—Diagram of Decussation of the Pyramids.
(Modified from Van Gehuchten)

At the surface of the upper part of each half, three structures which were examined during the preliminary survey of the brain can be recognised again at a glance. They are the pyramid, the olive and the inferior cerebellar peduncle.

Pyramid.—The **pyramid** is the bundle that lies alongside the anterior median fissure. It is composed of motor fibres which arise in the motor area of the cerebral cortex, and descend in the corona radiata, internal capsule, basis pedunculi and the anterior part of the pons into the medulla oblongata. The pyramid passes downwards into the lower part of the medulla. There, three-quarters of its fibres cross in the decussation and form a bundle called the *lateral cerebro-spinal tract*; this tract descends in the lateral white column of the spinal cord, and its fibres arborise around the motor cells of the cord. The remaining quarter of the pyramid forms the *anterior cerebro-spinal tract*; it descends along the anterior median fissure of the upper half of the cord, and comes to an end owing to its fibres having gradually crossed to arborise round motor cells of the opposite half of the cord.

Olive.—The **olive** is the oval elevation, about half an inch long, that lies lateral to the pyramid. The elevation is produced by an underlying collection of grey matter, shaped like a corrugated vase, called the *olivary nucleus*. The nucleus is probably concerned with equilibration, for a large bundle of fibres comes out of its mouth or hilum, crosses to the opposite side and enters the inferior cerebellar peduncle, forming, indeed, the chief bulk of it. This bundle is called the *olivo-cerebellar tract*.

Scrutinise the surface of the olive, and note a number of narrow, parallel ridges that curve across it. In some specimens they are very obvious; in others, careful inspection is required. They are bundles of fibres called *anterior external arcuate fibres*. They arise in nuclei on the back of the opposite half of the medulla, pass forwards and emerge through the median fissure and through the pyramid, and arch laterally to join the inferior cerebellar peduncle.

In some specimens a distinct bundle may be seen curving round the lower end of the olive. It is called the *circumolivary bundle*, and consists of cortico-pontine fibres that have, as it were, lost their way; instead of ending in the pons, they descend with the pyramid and then curve backwards below the olive and end in a small ridge of grey matter which lies on the surface of the inferior peduncle, and is a displaced nucleus pontis.

Inferior Cerebellar Peduncle (Corpus Restiforme).—The **inferior cerebellar peduncle** is the thick, rope-like bundle that lies postero-lateral to the olive. It begins about half-way down the medulla oblongata, and extends upwards and slightly laterally, gathering bulk as it ascends. When it reaches the lower border of the back of the pons, it bends abruptly backwards between the middle and superior cerebellar peduncles (Fig. 233) to enter the cerebellum, where it spreads medially and backwards like a fan. It is the chief connexion between the medulla and the cerebellum, and its *principal components* are the olivo-cerebellar tract, the anterior and posterior external arcuate fibres (pp. 499, 500) and the posterior spino-cerebellar tract (p. 501).

Spinal Tract of Trigeminal Nerve.—But the inferior peduncle does not form the whole of the surface district postero-lateral to the olive. The peduncle and the olive are separated by a fairly wide but shallow groove. In the floor of that groove, there is a group of fibres so closely applied to the peduncle that they seem to be part of it. These fibres are the **spinal tract of the trigeminal nerve,** which is a long, tapering bundle composed of sensory fibres of the trigeminal nerve. It begins where the sensory root of that nerve enters the pons ; it descends first through the substance of the pons, and then on the surface of the medulla oblongata ; and it extends even into the spinal cord, where it ends at the level of the second cervical nerve. The rootlets of the ninth, tenth and eleventh cranial nerves are a guide to its precise position in the medulla oblongata : the rootlets of the ninth and tenth pierce it ; those of the eleventh are immediately in front of it. Its *nucleus* is a long column of grey matter that underlies it, and is the upward continuation of the substantia gelatinosa of the spinal cord.

Auditory Nerve.—The **auditory nerve** has a close relation to the inferior peduncle. It is a compound nerve consisting of two nerves—the *cochlear nerve*, which is the nerve of hearing, and the *vestibular nerve*, which is the nerve concerned with equilibration. The cochlear and vestibular nerves are united together in their course between the internal auditory meatus and the lower border of the pons. At that point they separate. The vestibular nerve passes backwards between the peduncle and the spinal tract into the substance of the medulla to reach its nuclei, which lie, both in medulla and in pons, close to the floor of the fourth ventricle. The cochlear nerve curves backwards round the side of the peduncle and ends in two nuclei—a dorsal and a ventral—that lie on the peduncle.

The dissectors will now inspect the surface of the lower part of the medulla oblongata, and seek to identify the following structures in turn, beginning at the posterior median fissure:—

1. Fasciculus gracilis and gracile tubercle.
2. Fasciculus cuneatus and cuneate tubercle.
3. Spinal tract of trigeminal nerve.
4. Posterior spino-cerebellar tract.
5. Anterior spino-cerebellar tract.
6. Lower part of pyramid.
7. Decussation of pyramids.

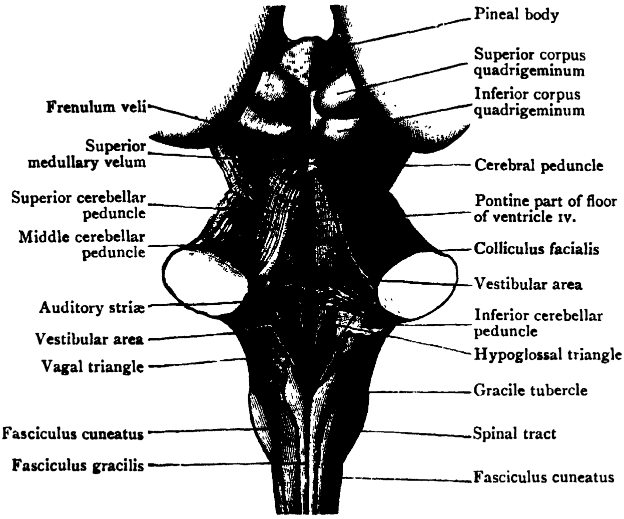


FIG. 224.—Posterior View of Brain-Stem of a full-time Fœtus.

The dissector will have little difficulty in identifying the first two on the list and the last two; but the other three are very indistinctly marked out.

Gracile and Cuneate Fasciculi.—The **fasciculus gracilis** is the slender bundle that lies alongside the posterior median fissure. It ends half-way up the back of the medulla in a little prominence called the *gracile tubercle* (clava). The

fasciculus cuneatus is immediately lateral to the fasciculus gracilis ; it extends to a slightly higher level, and ends in an ill-defined eminence called the *cuneate tubercle.*

The fasciculus gracilis and cuneatus are composed of sensory fibres that arise in the ganglia on the posterior roots of spinal nerves. The fibres are carried by the posterior nerve-roots into the spinal cord and form these two fasciculi, which ascend in the posterior white column of the spinal cord into the medulla oblongata.

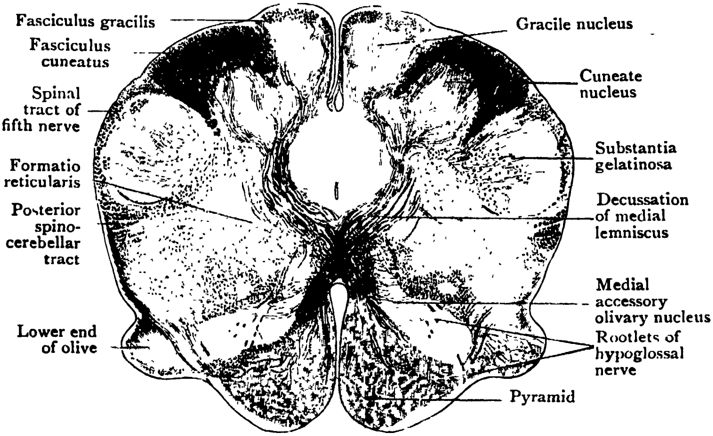

Fasciculus gracilis
Fasciculus cuneatus
Spinal tract of fifth nerve
Formatio reticularis
Posterior spino-cerebellar tract
Lower end of olive
Gracile nucleus
Cuneate nucleus
Substantia gelatinosa
Decussation of medial lemniscus
Medial accessory olivary nucleus
Rootlets of hypoglossal nerve
Pyramid

FIG. 225.—Transverse Section through lower part of Medulla Oblongata of a full-time Fœtus, above the Decussation of the Pyramids, treated by the Weigert-Pal method. The grey matter is white, and the medullated strands of nerve-fibres are black.

Nucleus Gracilis and Cuneatus, and Arcuate Fibres.—The gracile and cuneate tubercles lie immediately below the lower end of the inferior cerebellar peduncle. They are produced by the enlarged upper ends of the ***nucleus gracilis*** and ***nucleus cuneatus***, which underlie the upper parts of the fasciculi, and in which the fibres of the fasciculi end.

A large number of fibres arise in these nuclei. A few of them, called *posterior external arcuate fibres*, enter the inferior cerebellar peduncle at once, and form its commencement. The others are called **internal arcuate fibres**, and their course is not so simple. They arch forwards in fine bundles through the substance of the medulla, and cross the median plane, decussating with their fellows of the opposite side. As soon as they have crossed they divide into two groups.

(1) The fibres of one group bend upwards and form a large flat band called the *medial lemniscus* ; this lemniscus ascends, through the interior of the medulla, pons and mid-brain, to the thalamus, to which it conveys sensory impressions.

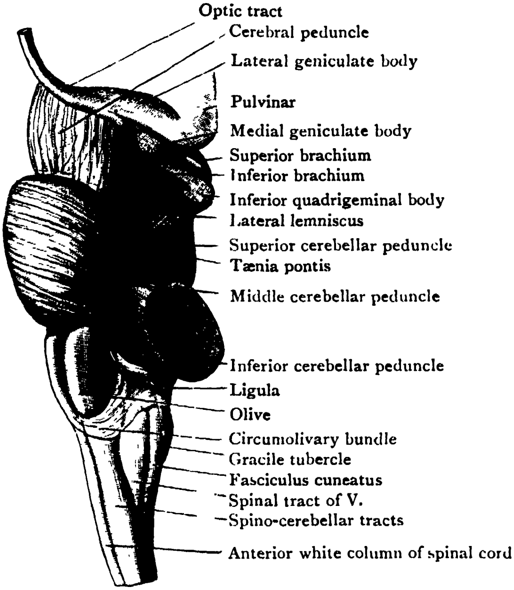


FIG. 226.—Lateral view of Medulla Oblongata, Pons and Mid-Brain of a full-time Fœtus.

(2) The fibres of the other group are much less numerous and are called the *anterior external arcuate fibres*. They continue to pass forwards, and then emerge on the front of the medulla through the pyramid and by its medial side (sometimes almost choking the median fissure), and have already been seen curving across the olive to reach the inferior cerebellar peduncle. All external arcuate fibres therefore reach the cerebellum, and they convey to it the afferent impressions transmitted to them from the gracile and cuneate fasciculi.

Spinal Tract of Trigeminal Nerve.—The lower part of this tract is the narrow bundle between the fasciculus cuneatus and the groove through which the rootlets of the accessory nerve issue.

Spino-cerebellar Tracts.—These tracts occupy the surface area between that groove and the groove which transmits the upper roots of the first cervical nerve. They are not marked off from each other, but each occupies about one half of the breadth of the area.

The **posterior spino-cerebellar tract** is the more lateral of the two. It extends upwards in the side of the medulla oblongata, and, about half-way up, it passes obliquely backwards across the spinal tract to join the inferior peduncle; this part, owing to its oblique direction, can probably be seen in the specimen.

The **anterior spino-cerebellar tract** runs straight upwards to the olive. Most of it disappears under cover of the olive, but a portion of it may be seen as a thin strip running up along the posterior edge of the olive. It then ascends through the pons, and, reaching its upper part, it bends backwards and then runs downwards in the superior peduncle into the cerebellum.

The spino-cerebellar tracts arise in the spinal cord, and convey to the cerebellum certain of the afferent impressions that reach the cord through the posterior nerve-roots.

The lower part of the **pyramid** and the **decussation** have been examined already.

Grey and White Matter of Medulla Oblongata.—The white matter is, for the most part, at the surface, and the various strands have been examined. In the interior the white and the grey matter are to a large extent mingled, and most of the strands of white matter have been mentioned in the account of the mid-brain and of the medulla; but very little detail can be made out except by microscopical examination of specially prepared sections. However, if a slice is made through the lower part, the central canal is seen as a black speck, and, if the specimen is fairly fresh, a thick compact tube of grey matter may be seen around it. Superiorly, this grey matter is continuous with the thick layer of grey matter which forms the floor of the fourth ventricle. The nuclei of the nerves are (1) in the grey matter in the floor of the ventricle, (2) in the grey matter around the canal, and (3) in more segregated collections that lie in the substance of the medulla.

Nerves associated with Medulla Oblongata.—The lower eight cranial nerves are connected with the medulla in greater or lesser degree ; and the upper fibres of the anterior root of the first cervical nerve arise in it.

The *fifth cranial nerve* is connected with the whole brain-stem. It has a nucleus in the mid-brain, more than one in the pons, and its spinal tract extends down the medulla oblongata into the spinal cord.

The *sixth nerve* belongs to the pons. Its only association with the medulla is that it pierces the upper end of the pyramid.

The motor nucleus of the *seventh* is in the pons ; but the sensory nucleus is in the upper part of the medulla—at the upper end of the nucleus of the ninth.

The association of the *eighth nerve* with the medulla is mentioned on p. 497.

The *ninth*, *tenth* and *twelfth* nerves belong wholly to the medulla oblongata ; but only the upper part of the *eleventh* arises in the medulla.

Pons.—The pons is the marked prominence interposed between the medulla oblongata and the mid-brain, in front of the cerebellum (Figs 174, 204). It is convex from side to side as well as from above downwards; and the transverse streaks on its surface show that, superficially, it is composed of transverse bundles of nerve fibres. On each side, the transverse fibres collect themselves together to form a large, compact strand which sinks, postero-laterally, into the hemisphere of the cerebellum. The strand is termed the *middle cerebellar peduncle*.

When the brain is *in situ*, the *anterior surface* of the pons is in relation to the basi-occiput, the dorsum sellæ, and the medial part of the back of each petrous temporal bone.

The anterior surface presents a median groove which lodges the basilar artery ; the blunt ridge that bounds the groove on each side is due partly to the longitudinal bundles of fibres of the pons that are continued into the pyramid of the medulla oblongata. Where the pons becomes the middle peduncle the trigeminal nerve is attached to its anterior surface, nearer its upper than its lower border.

Superiorly, the pons is continuous with the cerebral peduncles. *Inferiorly*, it is continuous with the constituent parts of the medulla oblongata—except the inferior cerebellar peduncles, which pass backwards into the cerebellum.

The *posterior surface* of the pons cannot be studied at present. It is turned towards the cerebellum, which hides it from view, and it forms the upper part of the anterior boundary or floor of the fourth ventricle.

White and Grey Matter of the Pons.—The pons is divided into an anterior or basilar part and a posterior or dorsal part.

The **basilar part** is the part seen in the base of the brain. It is composed chiefly of white matter; but amidst the white matter there are scattered nests of grey matter called the *nuclei pontis.* The white matter at the surface is composed wholly of transverse fibres; but, in the deeper part, transverse and longitudinal bundles intersect. The *transverse fibres*—both superficial and deep—connect the nuclei pontis with the grey matter of the cerebellum. The basis pedunculi plunges into the basilar part of the pons and breaks up to form the *longitudinal bundles.* Most of them are cortico-pontine fibres, and they end in the nuclei pontis. The remainder are motor fibres. A few of them cross to end in the motor nuclei of the opposite half of the pons. The rest of the motor bundles re-unite and emerge as the pyramid; the pyramid therefore

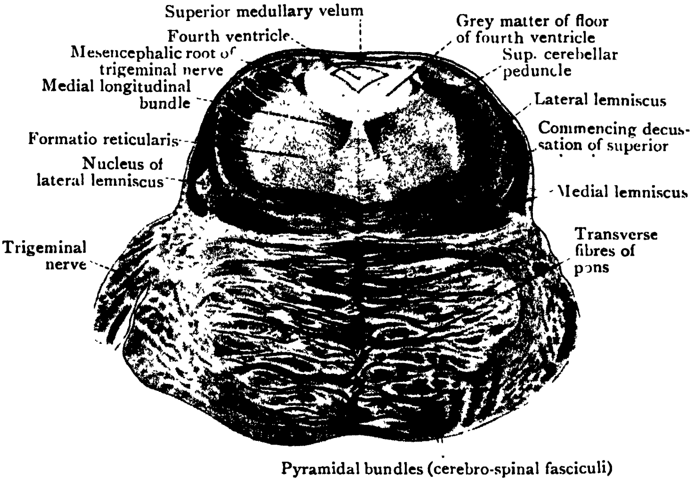

Superior medullary velum
Fourth ventricle
Mesencephalic root of trigeminal nerve
Medial longitudinal bundle
Formatio reticularis
Nucleus of lateral lemniscus
Trigeminal nerve
Grey matter of floor of fourth ventricle
Sup. cerebellar peduncle
Lateral lemniscus
Commencing decussation of superior
Medial lemniscus
Transverse fibres of pons
Pyramidal bundles (cerebro-spinal fasciculi)

FIG. 227.—Transverse Section through upper part of Pons of Orang.

includes all the fibres of the basis pedunculi that survive the passage through the pons.

The **dorsal part** is very much smaller. It is bounded on each side by the superior and inferior cerebellar peduncles; it is continuous superiorly with the tegmentum of the mid-brain, and inferiorly with the deeper and posterior parts of the medulla oblongata. It is composed of a mixture of grey and white matter covered posteriorly by the layer of grey matter of the floor of the fourth ventricle. The white matter includes the medial lemniscus—which lies next the basilar part—and various other tracts that connect the thalamus and the mid-brain with the parts below. The grey matter contains the nuclei of nerves.

Nerves associated with Pons.—Four cranial nerves have nuclei in the pons—fifth, sixth, seventh and eighth.

The *fifth cranial nerve* has two nuclei in the pons—a motor and a sensory—and its spinal tract, which also is sensory, begins in the pons.

The nucleus of the *sixth* is in the grey matter of the lowest part of the back of the pons, and the nerve passes forwards through the whole thickness of the pons to emerge at its lower border.

The motor nucleus of the *seventh* is deeply placed in the lower part of the pons, and the nerve runs a very devious course before it escapes from the pons.

The *vestibular* part of the eighth nerve has nuclei in the pons as well as in the medulla oblongata.

Cerebellum.—The main parts of the cerebellum are a pair of *hemispheres* united by a median portion called the *vermis*; but the distinction between those main subdivisions is not very evident on its upper surface.

Anteriorly and posteriorly there is a marked deficiency or notch in the median plane (Fig. 228). The *posterior notch* is occupied by the falx cerebelli, when the brain is in the skull. The *anterior notch* is very much wider. If the brain-stem were removed and the cerebellum looked at from in front, the notch would be seen to be really a long, wide groove; the back of the mid-brain and the superior cerebellar peduncles occupy its upper part (Fig. 228); the pons and medulla lie in its lower part, but are separated from its floor by the cavity of the fourth ventricle.

On the *superior surface* of the cerebellum, the part of the vermis seen is called the **superior vermis**, and there are, as already stated, no definite lines of demarcation between it and the upper surfaces of the hemispheres. The superior vermis forms a median ridge from which the surface slopes gradually downwards, on each side, to the margin of the hemisphere. From the anterior part of the superior vermis, a thin, tongue-shaped process, called the *lingula*, extends upwards between the two superior cerebellar peduncles, which pass from the cerebellum into the mid-brain. The lingula lies on the lower part of a thin, white lamina, called the *superior medullary velum*, which connects the two peduncles.

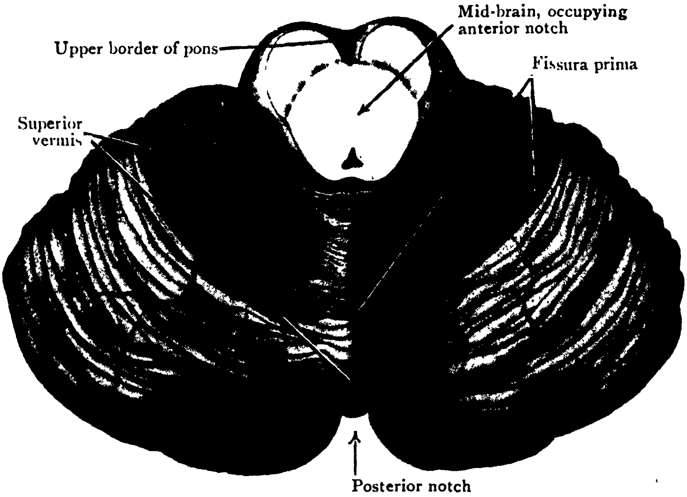


FIG. 228.—Cerebellum seen from above.

The morphological lobes are coloured—anterior *blue*, middle *yellow*.

The part of the vermis which is seen on the *inferior surface* of the cerebellum is called the **inferior vermis**, and the distinction between the vermis and the hemispheres is much better marked. On that aspect, the hemispheres are separated by a deep, median hollow, termed the *vallecula cerebelli*, into which the inferior vermis bulges.

The upper and lower parts of each hemisphere are separated by a cleft, called the **horizontal fissure**, which sweeps round the margin from the anterior notch to the posterior notch. Examine the anterior part of the fissure: it widens there to receive the middle cerebellar peduncle; and, at its junction with the anterior notch, the superior peduncle leaves the cerebellum and the inferior peduncle enters it between the superior and middle peduncles.

In addition to this general description of the form of the cerebellum, there are many subdivisions of both vermis and hemispheres to which names have been attached—some of them rather fanciful. The exact significance of most of these parts is not understood; but certain of these old names are provisionally retained for those parts that seem to be morphologically distinct (*lingula*, *flocculus* and *paraflocculus*, and the divisions of the inferior vermis—*nodule*, *uvula* and *pyramid*, Figs. 229-232).

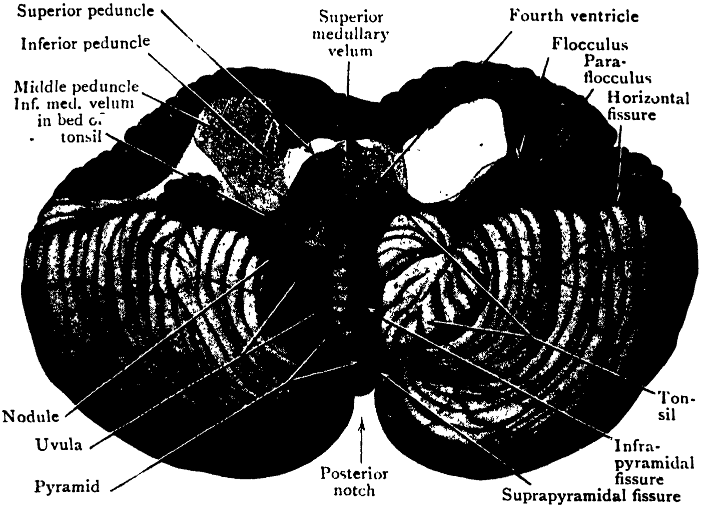


FIG. 229.—Cerebellum seen from below. The right tonsil has been removed and the inferior medullary velum fully exposed.

The morphological lobes are coloured—anterior *blue*, middle *yellow*, and posterior *green*.

More important is the fact that the true subdivision of the cerebellum is not into median vermis and lateral hemispheres (which, as already noted, are directly continuous on the upper surface of the organ) but in the cranio-caudal direction by fissures that cut transversely into the vermis and are continued laterally and forwards into each hemisphere.

The most important of these fissures appears on the upper surface of the cerebellum about the end of the third month of intra-uterine life ; it is called the *fissura prima*, and its position is shown in Figs. 228, 230, 232. It divides the cerebellum into two primary parts or *lobes*. The part in front of the fissura prima is named the *anterior lobe* ; the part behind is sometimes spoken of simply as the "posterior lobe," but, in accordance with studies in comparative anatomy, it may be subdivided into *middle* and *posterior lobes*, as shown in Figs. 229-232.

These lobes are so named from their relative position during a phase of development, and their ultimate relation to each other is seen in Figs. 228 and 229, and also in Figs. 230 and 231, which illustrate them separated by dissection. Owing to a developmental rotation of the cerebellum due to expansion as it grows, the hinder part of it comes to lie beneath the fore part ; and it will be seen in Fig. 232 that, in the fully-formed cerebellum, the topographical position of these anterior, middle and posterior lobes is respectively superior, posterior and inferior.

The chief points to note about this subdivision of the cerebellum are :—(1) Each lobe has a median part and a pair of lateral extensions. (2) The *anterior lobe* is uniformly developed. (3) The *posterior lobe* has a well-developed median part (the inferior vermis) but only a rudimentary pair of lateral extensions (the flocculus and paraflocculus), to which the median part is connected by the two halves of a thin, white sheet called the inferior medullary velum. (4) The *middle lobe* has a very narrow median portion and relatively large lateral extensions, which, indeed, form the greater part of the two hemispheres. The horizontal fissure is not a primary cleft, but appears in the middle lobe owing to the exuberant growth of its lateral extensions.

This morphological division of the cerebellum has not yet been related with certainty to its functions. The difficulty of preserving bodily balance and the appearance of other general muscular symptoms when the cerebellum is diseased shows that it has to do with equilibration and with the maintenance of muscular tone and activity, but the question whether it acts as a whole in relation to motor impulses or exhibits motor localisation like the cerebral cortex has not been finally settled. The contrasting characteristics of the three lobes fit in, however, with a scheme of localisation which places the Head in the anterior lobe, the Trunk in the posterior lobe, and the Limbs in the lateral extensions of the middle lobe—the body being thus represented in the cerebellum neither crossed nor inverted as in the cerebral cortex. The enormous expansion of the lateral parts of the middle lobe, which is a special feature of the human cerebellum, is, in this scheme, related to the highly specialised movements of which the human limbs are capable.

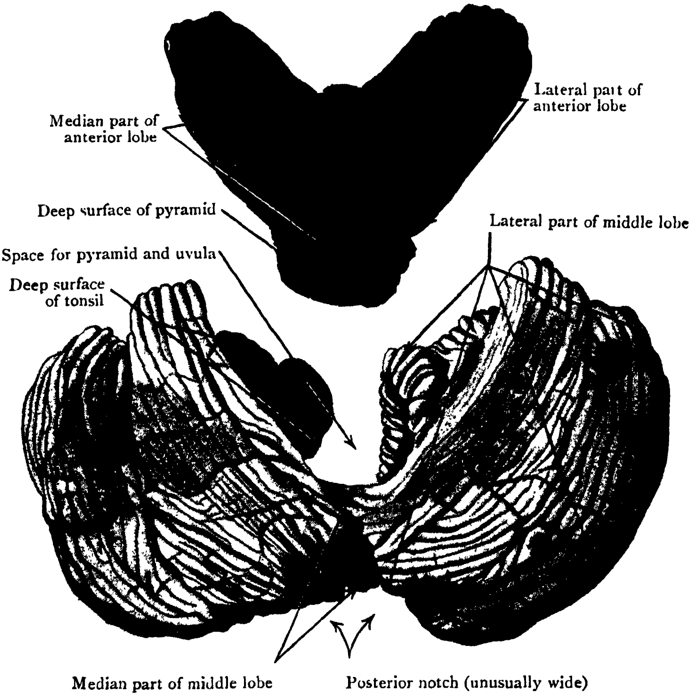

Lateral part of anterior lobe
Median part of anterior lobe
Deep surface of pyramid
Lateral part of middle lobe
Space for pyramid and uvula
Deep surface of tonsil
Median part of middle lobe
Posterior notch (unusually wide)

FIG. 230.—Separated morphological Lobes of Cerebellum, seen from above.

The anterior lobe is coloured *blue*, the posterior *green*, and the middle lobe, which has been detached from the others and moved backward, is *yellow*.

***Dissection.*—Make a median section through the vermis and the superior medullary velum into the cavity of the fourth**

ventricle. When the two parts of the cerebellum are drawn slightly asunder, a view of the fourth ventricle is obtained; further, the connexions of the two medullary vela and the arrangement of the peduncles of the cerebellum can be more clearly understood.

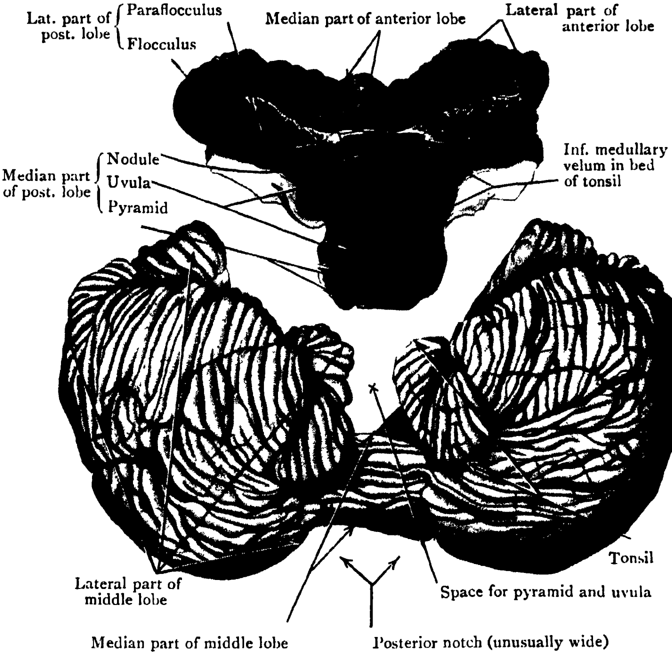

Lat. part of post. lobe
Paraflocculus
Flocculus
Median part of anterior lobe
Lateral part of anterior lobe
Median part of post. lobe
Nodule
Uvula
Pyramid
Inf. medullary velum in bed of tonsil
Tonsil
Lateral part of middle lobe
Space for pyramid and uvula
Median part of middle lobe
Posterior notch (unusually wide)

FIG. 231.—Separated morphological Lobes of Cerebellum, seen from below.

The anterior lobe is coloured *blue*, the posterior *green*, and the middle lobe, which has been detached from the others and moved backwards, is *yellow*.

Arbor Vitæ Cerebelli.—The cut surface of the cerebellum presents a very characteristic appearance. The grey matter on the surface stands out distinctly from the white matter in the interior; and the complete manner in which the surface is cut up by the fissures into secondary and tertiary folia is seen. The central mass of white matter in the vermis sends prolongations into the various lobules, and they give off branches to supply each folium with a central white core. The term *arbor vitæ* is applied to the appearance which consequently results when a section is made through the cerebellum (Fig. 232).

Cerebellar Peduncles.—The three pairs of cerebellar peduncles connect the cerebellum with the medulla oblongata, the pons and the mid-brain. They are all composed of fibres which emerge from or enter the white central substance of the cerebellum.

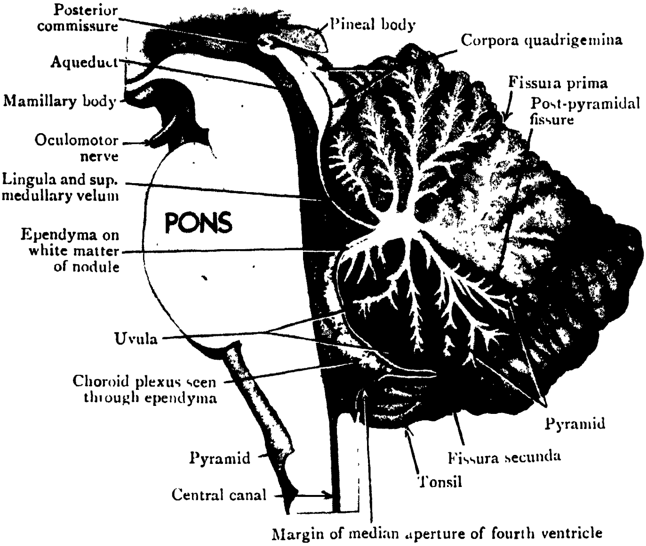


FIG. 232.—Median Section through Brain-Stem and Cerebellum showing Arbor Vitae of Vermis.

Morphological lobes are coloured—anterior *blue*, middle *yellow*, and posterior *green*.

The **middle peduncle** (brachium pontis) is much the largest of the three. It is composed of the transverse fibres of the pons, and it enters the cerebellar hemisphere, on the lateral side of the other two, through the wide, anterior part of the horizontal fissure (Fig. 229). Note again the *flocculus*, which lies on the lower surface of the peduncle as it enters the cerebellum.

The **inferior peduncle** (restiform body) leaves the medulla oblongata and passes on to the dorsum of the pons; but almost at once it turns sharply backwards and enters the cerebellum between the other two peduncles (Figs. 229, 233).

The **superior peduncle** (brachium conjunctivum) is composed of fibres which come, for the most part, from a large collection of grey matter called the *nucleus dentatus* situated in the midst of the white substance of the cerebellar hemisphere. As the superior peduncles issue from the cerebellum, they lie close to the medial sides of the middle peduncles. They then proceed upwards towards the inferior pair of quadrigeminal bodies and are partly embedded in the dorsal part of the pons. They form the lateral boundaries of the upper part of the fourth ventricle, but incline towards each other so that they overhang the fourth ventricle and enter into the formation of its roof also. They disappear under cover of the inferior corpora quadrigemina, and at once begin to cross the median plane, decussating with each other; and the fibres of each end in the red nucleus of the opposite half ot the mid-brain (Figs. 206, 207, 226, 233).

Medullary Vela.—The medullary vela are thin laminæ of white matter which are projected out from the central white core of the cerebellum.

The **superior medullary velum** stretches across the interval between the two superior peduncles, and is directly continuous with their medial or dorsal margins. It is triangular in form, and is continuous below with the white matter of the cerebellum. The lingula of the cerebellum lies on the lower part of its dorsal surface. A median ridge of white matter, called the *frenulum veli*, descends from the floor of the groove between the inferior corpora quadrigemina to fuse with the upper part; and the trochlear nerve, having crossed from the opposite side, issues from its substance close to the frenulum.

The **inferior medullary velum** has a median part and a right and a left lateral part. The median part is in front of the anterior end of the inferior vermis; it is very small, and may be absent. Each lateral part is a wide, curved sheet—so thin that it is translucent. It lies lateral to the anterior part of the inferior vermis, and, at present, is quite hidden by a part of the cerebellum called the *tonsil* (Fig. 229).

To see the inferior medullary velum, remove the tonsil, using the handle of the knife for the purpose. The *tonsil* is the part of the cerebellar hemisphere which lies close to the side of the medulla oblongata, behind the medial part of the flocculus, and has some resemblance to an enlarged tonsil of the throat. Its removal exposes a rounded hollow that resembles a bird's nest. The inferior medullary velum lines the bottom of the nest. Lift it up carefully, and note how thin it is. Posteriorly and medially it is continuous with the white substance of the cerebellum. Laterally it is continuous with the stalk of the flocculus. Traced from behind, it curves over the top of the tonsil, and then downwards to end in a free edge. It forms the lower wall of the retro-curved peak of the roof of the fourth ventricle. Its deep or upper surface is therefore covered with ependyma; and, that part of the cavity of the ventricle being a mere chink, its ependymal surface is almost in contact with the superior cerebellar peduncle.

In order that a fuller view of the fourth ventricle may be obtained, a further dissection is necessary.

***Dissection.*—On one side, cut through the three peduncles, and so separate one half of the cerebellum—which must be preserved for future use.**

Fourth Ventricle.—The fourth ventricle is the cavity of the hind-brain, and is therefore enclosed by the cerebellum, pons and medulla oblongata. Portions of the cerebellum form its posterior boundary or roof; the pons and medulla oblongata form its anterior boundary or floor. The floor and the roof meet at the sides, and its lateral boundaries are therefore the lateral margins of the floor.

Roof of Fourth Ventricle.—The roof bears a general resemblance to a tent, especially when seen in a median section such as has been made in the student's own specimen. In that section the peak of the roof is immediately above and in front of the inferior vermis (Figs. 204, 232). But if a section were made to one side of the median plane, it would be seen that the peak is prolonged downwards and backwards as a narrow chink, curved in conformity with the curvature of the lateral part of the inferior velum.

The upper part of the roof is formed of the superior medullary velum and superior peduncles and the white matter of the cerebellum out of which they proceed. The middle part is formed of the inferior medullary velum. The lower part consists of the ependyma only. In this lowest part there is a hole in the ependymal roof and in the overlying pia mater. The hole is called the **median aperture of the fourth ventricle.** It looks downwards rather than backwards, and is of variable dimensions. Through it, the cerebro-spinal fluid escapes from the interior of the brain into the subarachnoid space. The lower part of the roof and the foramen can be seen only if special precautions are taken. In the student's own specimen, the lower part of the roof, since it consists of ependyma only, was torn away with the overlying pia mater, to which it is adherent.

Floor of Fourth Ventricle.—The floor is composed of a thick layer of grey matter spread over the back of the pons and the upper half of the medulla oblongata ; it contains the nucleus of the abducent nerve, and parts of the nuclei of the vestibular, glosso-pharyngeal, vagus, and hypoglossal nerves.

The floor is diamond-shaped. The aqueduct opens into the ventricle at the *upper angle*, and the central canal at the *lower angle*. The *lateral boundaries* are, from above downwards, the superior peduncle, the inferior peduncle, the cuneate tubercle and the gracile tubercle. The lateral angle is at the meeting point of the peduncles. Immediately below the lateral angle, a narrow pocket of ependyma extends laterally over the inferior peduncle, and onwards, behind the roots of the ninth and tenth nerves, as far as the flocculus. The cavity of the pocket is called the *lateral recess* of the fourth ventricle. Near the end of the pocket, there is a breach in the ependyma and the overlying pia mater ; this opening is called the **lateral aperture of the fourth ventricle** ; and, like the median aperture, it serves for the escape of cerebro-spinal fluid out of the ventricle into the subarachnoid space.

The floor of the ventricle is divided by a median groove into right and left halves. The smooth elevation alongside the median groove is called the *eminentia medialis*, and it presents, above its middle, a slight swelling called the *facial colliculus*. The colliculus marks the position of the nucleus of the abducent nerve, and is produced by the facial nerve, which, in one part of its devious journey through the pons, curls round the abducent nucleus.

A few slender bundles of transverse fibres may be seen shining through the ependyma which carpets the floor. They cross the middle of each half of the floor and disappear into the median groove. They are called *auditory striæ*, for they arise in the dorsal nucleus of the cochlear nerve, which is placed on the inferior peduncle near the pons; and they divide each half of the floor into a *pontine part* above, and a *medullary part* below.

In the medullary part, there is a small Λ-shaped depression called the *inferior fovea*. It divides this part into three triangular areas. The area between the fovea and the median sulcus is identical with the lower part of the eminentia medialis, and is called the *hypoglossal triangle* because it overlies the upper part of the nucleus of the twelfth nerve. The area between the limbs of the fovea is called the *vagal triangle*; it overlies the upper part of one of the nuclei of the ninth and tenth nerves. The area lateral to the fovea is part of the *vestibular area*, which corresponds to nuclei of the vestibular nerve, and extends, therefore, into the pontine region; the auditory striæ cross the vestibular area.

The depth at which the auditory striæ lie varies in different specimens, and they may not be visible on the surface at all. The very obvious striæ that are seen crossing the floor of the ventricle at this level in some specimens are probably wandering arcuate fibres (pp. 496, 500).

In the pontine part of the floor, there is a shallow, ill-defined angular depression, called the *superior fovea*, between the vestibular area and the facial colliculus. In the uppermost part, the eminentia occupies nearly the whole breadth of the floor, but on its lateral side there may be seen a narrow area which has a bluish tinge and is called, therefore, the *locus coeruleus*. The colour is produced by a dark-coloured patch of grey matter, called the *substantia ferruginea*, which underlies the ependyma.

Tela Chorioidea and Choroid Plexuses of Fourth Ventricle.—The pia mater that covers the lower part of the roof of the ventricle extends upwards to the root of the inferior velum and is then reflected backwards to become continuous with the pia mater on the overlying part of the cerebellum. The layer on the roof of the ventricle and the layer on the contiguous part of the cerebellum are so closely applied that they are to some extent adherent to each other; and, together, they form a fold called the *tela chorioidea* of the fourth ventricle.

The *choroid plexuses* of the fourth ventricle are vascular plexuses developed in the tela. They take the form of a pair of columns with lateral extensions. The columns lie close to the median plane—almost side by side—and bulge the ependymal roof into the cavity; and their lower ends bulge out again through the median aperture to lie on the lower surface of the cerebellum. Their upper ends are united to each other across the median plane, and each sends an extension along the lateral recess. This extension bulges the posterior wall of the recess into the cavity; its lateral extremity protrudes again through the lateral aperture and swells to form an excrescence that resembles a cauliflower in miniature, and is well seen if the hind-brain is examined before the membranes are removed.

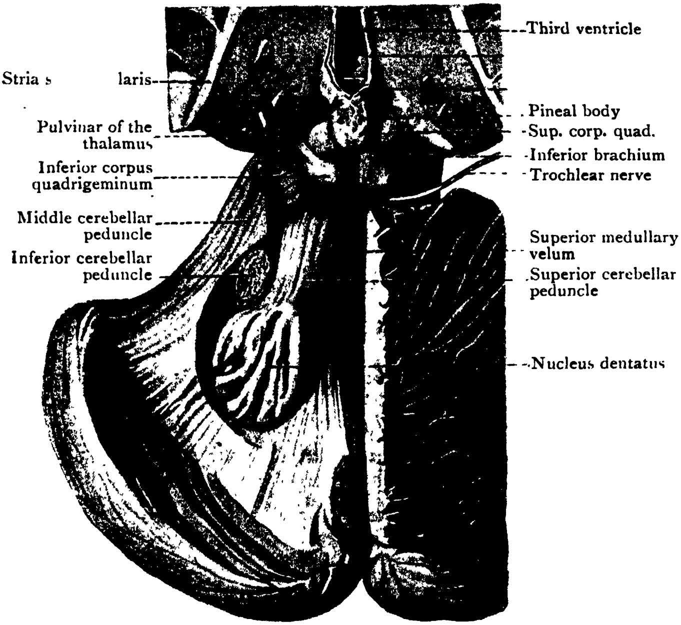


FIG. 233.—Dissection to show Dentate Nucleus, Cerebellar Peduncles, and Lateral Lemniscus.

The dissectors will now examine the manner in which the peduncles enter the cerebellum; and they will also study the nucleus dentatus.

Dissection.—**Take the half of the cerebellum which is connected with the brain stem, insert your fingers into the anterior part of the horizontal fissure, and tear away the upper part of the cerebellum. That will disclose the *superior peduncle*, and, to some extent, the others also. Note the place where the**

superior peduncle merges into the white mass. Then, with blunt-pointed forceps, remove the white matter behind the superior peduncle piecemeal till grey matter is reached. That grey matter is the *dentate nucleus* (Fig. 233). Clean a portion of its upper surface to display its corrugated appearance. Next, by cautious removal of white matter, isolate the inferior peduncle as it appears between the other two peduncles, close to the anterior part of the dentate nucleus.

Now, turn to the other half of the cerebellum, and make a sagittal section through it in the line of the superior peduncle. That will reveal the dentate nucleus in section and show its relation to the fourth ventricle.

Nucleus Dentatus.—The dentate nucleus is a collection of grey matter embedded in the white matter of the hemisphere of the cerebellum. Its appearance is similar to that of the olivary nucleus. It is a thin lamina of grey matter, which appears, on section, as a wavy line folded upon itself so as to form a crumpled grey capsule with a wide mouth or hilum directed forwards and medially. The greater number of the fibres which build up the superior cerebellar peduncle arise within it and issue from its mouth. A portion of the white matter below it appears in the roof of the fourth ventricle, where it forms the floor of the "bird's nest" (p. 512). When the nucleus is exposed from above, it is seen to be about the size of a thumb-nail, and its surface is rough and ridged.

Small nuclei lie in the white centre of the vermis, but they are so minute that they can seldom be detected in the dissecting-room.

Deep Dissection of Pons.—The dissectors should now trace the fibres of the basis pedunculi downwards through the pons, and then endeavour to display the medial lemniscus. The manner in which the basis breaks up into bundles when it enters the pons is explained on p. 503. In a previous dissection, the students displayed the lateral lemniscus on the surface of the superior cerebellar peduncle; they should choose that half of the brain-stem for this dissection.

Dissection.—Make two shallow sagittal cuts through the basilar part of the pons—one in the median plane and one along the medial side of the trigeminal nerve, and *deepen these cuts as the dissection proceeds.*

With blunt-pointed forceps, remove the transverse fibres of the pons between the cuts till the longitudinal bundles are reached. With fine-pointed forceps, pick out the transverse fibres from among the longitudinal bundles that you find first. Note that some of the bundles cannot be traced far, for their fibres end in the nuclei pontis; but those bundles which consist of the cerebrospinal motor fibres can be traced to the pyramid.

When some of the bundles have been traced into the pyramid, cut across the upper end of the pyramid and tear it away. That will disclose a white, glistening band, which is the anterior edge of the medial lemniscus.

Then, cut across the lower part of the basis pedunculi (Fig. 234), and, deepening the sagittal cuts through the pons, remove

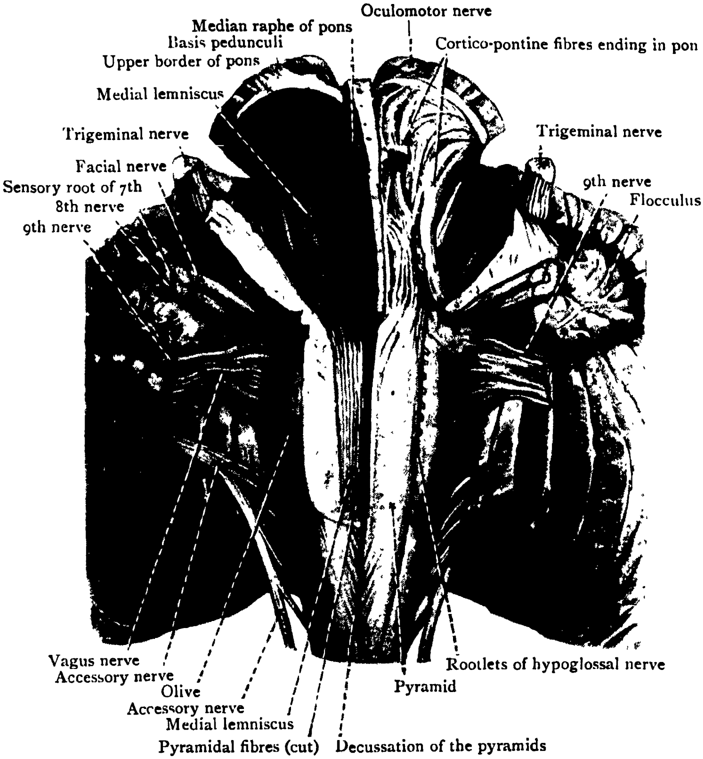


FIG. 234.—Dissection of Pons and Medulla Oblongata to show Cortico-Pontine and Pyramidal Fibres and Medial Lemniscus.

the basilar part of the pons to a considerable depth—about half an inch.

Now, return to the medial lemniscus in the medulla, follow it into the pons (where it quickly widens out) and trace it upwards, removing the remaining part of the basilar part of the pons, till the lemniscus disappears into the mid-brain behind the substantia nigra. Proceed with caution; but the lemniscus is very much nearer the back of the pons than the front, and failure to

find it is due usually to the dissector having abandoned the search too soon.

Medial Lemniscus.—The medial lemniscus is a great sensory tract (p. 468), and its fibres are derived from the nucleus gracilis and cuneatus of the opposite side (p. 499).

In the upper part of the medulla oblongata it forms a flat band that lies alongside the median plane, immediately behind the pyramid, with its edges directed forwards and backwards. As it enters the pons, it is twisted so that its anterior margin becomes lateral, and its surfaces are directed forwards and backwards. It ascends in the deepest (most anterior) part of the dorsal division of the pons, and then traverses the tegmentum of the mid-brain to end in the thalamus.

In both medulla and pons, it is joined by fibres from the sensory nuclei of the cranial nerves of the opposite side. The auditory fibres, however, soon leave it. They pass more or less transversely through it, forming an ill-defined, flattened bundle called the *corpus trapezoideum*, and, passing out of the pons, form the *lateral lemniscus*. The lateral lemniscus has been exposed already, and the dissectors may note that it is obliquely continuous with the lateral margin of the medial lemniscus.

CRANIAL TOPOGRAPHY

After the various parts of the brain have been carefully studied, the dissectors should obtain a bisected skull, and should study the relationships of the various gyri and sulci of the supero-lateral surface of each hemisphere to the bones of the cranial vault and to the grooves for the main branches of the middle meningeal vessels. They should note especially, in relation to the bones and the arterial grooves, the situations of the posterior ramus of the lateral sulcus, the central sulcus and the occipital pole of each hemisphere, because :—(1) the auditory area lies in the lower lip of the posterior ramus ; (2) the pre-central gyrus, which lies in front of the central sulcus, is the motor area ; (3) the post-central gyrus, which lies behind the central sulcus, is the sensory area ; and (4) the occipital pole is in the region of the visual area (Figs. 179, 235).

The main stem of the anterior branch of the middle meningeal artery lies, as a rule, opposite the pre-central gyrus (Fig. 235). The posterior branch is less constant in position, but is usually opposite the superior temporal gyrus, which is immediately below the posterior ramus ; and consequently the line of the artery crosses the auditory area.

The general positions of the sulci and gyri are shown in Figs. 177-179 ; and in Fig. 195, which is a reproduction of a radiograph of a head in

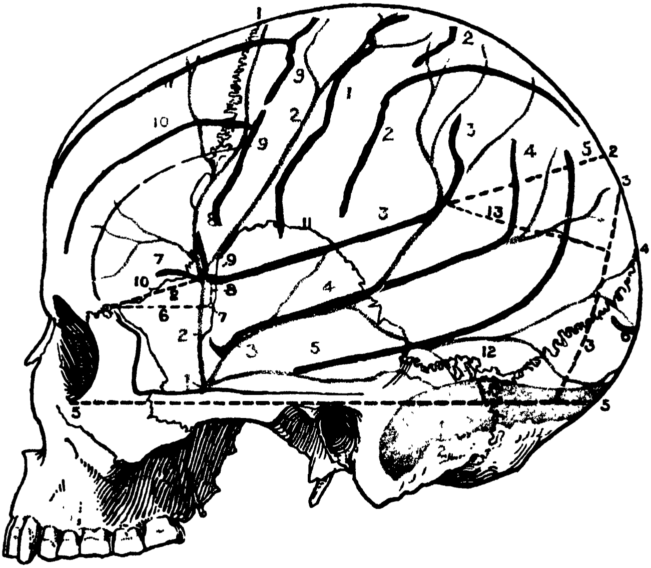


FIG. 235.—Diagram of Left Side of Skull, showing the Relations of Cerebral Sulci and Branches of the Middle Meningeal Artery to the Bones.

BLACK

1. Bregma.
2. Line of lateral sulcus and upper end of parieto-occipital sulcus.
3. Artificial line that separates the occipital lobe from the parietal and temporal lobes.
4. Lambda.
5. Eye-ear plane or base-line.
6. Horizontal line, 30 mm. long, parallel with eye-ear plane.
7. Lower end of vertical line.
8. Vertical line, 10 mm. long.
9. Near the pterion.
10. Spheno-frontal suture.
11. Squamo-parietal suture.
12. Above asterion—the meeting point of parietal, occipital and temporal bones.
13. Artificial line of separation between the posterior parts of the parietal and temporal lobes.

BLUE

1. Central sulcus.
2. Post-central sulcus.
3. Posterior part of posterior ramus of lateral sulcus.
4. Superior temporal sulcus.
5. Inferior temporal sulcus.
6. Posterior end of post-calcarine sulcus.
7. Horizontal anterior ramus } of lateral
8. Ascending anterior ramus } sulcus.
9. Pre-central sulcus.
10. Inferior frontal sulcus.
11. Superior frontal sulcus.
12. Sigmoid sinus and mastoid tempora bone.

RED

1. Stem of middle meningeal artery.
2. Anterior branch } of middle
3. Posterior branch } meningeal artery.

which metallic rods and pieces of metallic paste had been introduced. Other important areas also have been made visible.

The exact positions of the various cerebral sulci vary, to a certain extent, in heads of different shapes and sizes, but a sufficiently accurate estimation, for practical purposes, can be made on any head or skull by the use of a few easily remembered points and lines (Fig. 235). They are :—

1. A base-line or eye-ear plane, which extends from the lower margin of the orbit to the upper border of the external auditory meatus (5-5, black).

2. A line, 30 mm. long, drawn backwards from the lower end of the zygomatic process of the frontal bone, ***parallel with the eye-ear plane*** (6, black).

3. A line, 10 mm. long, drawn upwards at right angles to 2 from its posterior end (8, black). The upper end of 3 is at or near the pterion, and it marks the position where the lateral end of the stem of the lateral sulcus divides into its three rami (9, black).

4. A line drawn from the lower end of the zygomatic process of the frontal bone, ***through the pterion***, to the median plane (2-2, black). This line usually strikes the median plane a short distance above the lambda ; the first three inches of it, behind the pterion, mark the position of the straight part of the posterior ramus of the lateral sulcus, and the last three-quarters of an inch indicates the position of the upper end of the parieto-occipital sulcus.

5. A line that marks the general position of the central sulcus. It begins one inch behind the pterion, immediately above the line for lateral sulcus, and extends upwards and backwards to a point in the median plane situated half an inch behind the mid-point between the root of the nose (nasion) and the centre of the external occipital protuberance (inion) (1, blue).

The occipital pole of the hemisphere lies immediately above and lateral to the external occipital protuberance.

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